

THIS BOOK IS THE PROPERTY OF:
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**THE
NECROPSY
BOOK**

**King
Dodd
Newson
Roth**

**New York State College of Veterinary Medicine
Cornell University
Ithaca, New York 14853
March 1989**

Lesions

Location

Color

Size/Weight

Shape

Consistency

Number (#) or Percent (%) Involved

Content

**There are many common lesions
but never any normal ones.**

Morphological descriptions and interpretations
of lesions may include the the following:

Distribution	Organ(s)	Unilateral - Bilateral		
		Focal - Multifocal -		
		Locally Extensive - Diffuse		
	Whole Body	Localized		
		Generalized		
Time	Peracute - Acute - Subacute - Chronic			
Severity	Minimal	Moderate	Marked	Severe
		Slight		
Causal	Verminous - Bacterial - Chemical - Viral -			
	Traumatic - Protozoal - Mycotic - Toxic - etc.			
Type	Croupous - Hemorrhagic - Purulent - Fibrinous -			
	Fibrinopurulent - etc.			

**It is often wise to ask yourself or a student if they think it's
Normal - Artifact - Autolytic - Known Lesion - Parasitic?**

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INTRODUCTION

A method for doing a necropsy (an autopsy done on an animal) using the horse as a model is described. Since the use of the horse may be questioned we could merely reply that we had to use an animal and the horse at least is ubiquitous. Another reason not usually expressed is that the horse not only has a single stomach as does the pig, dog and cat, but also has large fermentation chambers equivalent in function to the rumen of the ox and sheep.

The actual procedure of doing the necropsy is one of many used by veterinary pathologists and its practicality and adaptability have been demonstrated. We make no claim for the superiority of this method over others, but from considerable experience with it we know it can be used with facility on all species under consideration; by adhering to it, no organ will be and no lesion should be overlooked. No special equipment or instruments are required. Any phase of the procedure can easily be modified to suit the prosecutor's special needs or interests. We stress, however, that after having acquired facility and speed with one procedure, it is unwise to change it capriciously; a different method usually takes more time and may cause one to forget a necessary part of the procedure. A change in technique may also preclude instant recognition of an absent or displaced organ or otherwise familiar abnormality. For instance, the pylorus and first part of the duodenum are always close to view when the abdomen is opened by this technique and, if not directly in view, one should immediately consider a twist or displacement of the stomach. The first kidney observed is the right kidney and if it's the only one with the cranial pole infarct this can be remembered more easily if one necropsies all animals with the animal's right side up.

THE HISTORY

Ideally a complete history should be available prior to the necropsy and often it is, for the clinician doing his own necropsies, but sometimes it is not and in fact to some pathologists it is important for them to do a necropsy without being prejudiced by an erroneous, misleading or incomplete history. Often the individual doing the necropsy will erroneously not finish doing a complete necropsy when some obvious but not necessarily important or fatal lesions is found. For instance, a brain lesion may be the cause for inhalation pneumonia in an adult animal but if the pneumonia is severe enough, the pathologist may quit the necropsy before he takes out the brain. Take the history in all cases by first filling out the request form. A model one is given.

The Necropsy Report

Fill out the Necropsy Report Form as requested. The date is often a legal requirement. You'd be lost in a law court without it.

The **Animal's ID** usually refers to its given name, ear tag or tattoo number. **Species, Breed, Sex** and **Age** are most helpful and required. **Died/Killed** - Indicate the correct one. **Method of Euthanasia** - tell us how this was done and with what, i.e. intracardiac barbiturate, halothane, gunshot, etc. **Date and Time of Death** - do not make the common error of accepting the time when the animal was found dead with the actual time of death. Establish it yourself if possible. **Total Number Affected** - the obvious is necessary. **Duration of Illness** - of great importance in history taking. **Antemortem Diagnosis** - give several if necessary. **Body Weight** - helpful and necessary.

NECROPSY REQUEST FORM

Date _____

Diag. Vet. Acct # _____ Clinic # _____ Post Mortem # _____

Animal's ID _____ Species _____ Breed _____ Sex _____ Age _____

Died/Killed _____ Method of Euthanasia _____ Date & Time of Death _____

Total number of animals on premises: Adult _____ Young _____

Total number affected with this problem: Adult _____ Young _____

Duration of illness: _____ Was this animal/case seen by a Veterinarian Yes No

Antemortem Diagnosis: _____ Body weight _____

Veterinarian: _____ Client: _____

Address: _____ Address: _____

City _____ State _____ Zip _____ City _____ State _____ Zip _____

Telephone # (____) _____ area _____ Telephone # (____) _____ area _____

HISTORY: Please include a complete history to include feed/husbandry changes, new animals, treatments, date of onset of illness, etc.

FEE REQUIRED

Clinician/Owner Signature

NOTICE

**REPORT/RESULTS/BILL
SENT DIRECTLY TO
VETERINARIAN**

Use reverse side if necessary

Additional copies to be sent to _____

Provisional Gross Diagnosis _____

Koda _____ Histo _____ Bact _____ Virol _____ Parasit _____ Toxicol _____ Freezer/Storage _____

List tissues
as needed:

Student _____ Intern/Resident _____ Pathologist _____

Initial report via phone by _____ on _____ to _____

Veterinarian:

Absolutely necessary as we report to the veterinarian in all cases. Include the phone number if possible.

Client:

Absolutely necessary, including the owner's signature for permission legally to do the necropsy. Point out to the owner the fee requirement.

History: *Fill in all pertinent history. Attach extra sheets if available.*

Additional Copies: Medical Records will send these out to clinicians and those listed.

Provisional Gross DX - please fill this in after the necropsy, as it will help the ancillary labs to determine their testing procedures.

Koda - Histo, etc. - should be checked off if used and note each tissue involved.

Student, etc. - fill these in.

Initial Report By - the necropsy room supervisor usually calls the referring clinician the next morning, but if anyone contacts the involved clinician before this time, it should be **noted on** the sheet so the referring clinician is not bothered twice by an unnecessary call.

Almost all of the requested facts above are of great legal value and should be given if possible.

. . .

Of course the necropsy must come before the descriptive write up, but we've given the write up technique first to make the prosector aware of what should be looked for and thus a hint of what to be aware of before doing the necropsy.

The Gross Necropsy Description and Write Up

An important part of the necropsy is the description of lesions, but prosectors and especially neophytes should realize all findings may not be lesions, that is they may not be abnormal changes in structure (or function). In fact, it is more often the case that the neophyte will consider lesions - such things as (1)

physiological changes, gastrointestinal congestion or post-mortem hypostasis in the lung and liver as antemortem congestion or even hemorrhage. **(2)** Normal features as the torus pyloricus in the pig stomach, the normal duodenal papillae in the horse and dog, which are often mistakenly called tumor nodules or ulcers. Prominent lymphoid foci in the colon or even Peyer's patches are misdiagnosed as ulcers. **(3)** Artifacts, which are changes caused at, or just after death, either physically or chemically are not antemortem changes. Barbiturate salt deposition on the pleura is a good example, and so are changes associated with rat or other wild animal eating of a dead carcass. **(4)** Post-mortem changes in all species associated with decomposition are the most commonly misdiagnosed changes and range from nasal froth to mucosal sloughing of the forestomachs in ruminants.

We often tell the novice that most things seen during a necropsy fall into several categories which include **normal**, **artifact**, **post-mortem change** (autolysis), **parasite lesion**, and last but not least, **lesions of significance**. Thus, with three out of five changes being of no great significance, it's no wonder the neophyte may be in error.

The first sentence should be an overall complete description of the carcass and its condition. In the actual prosaic write up (in the present tense) of a necropsy report of an individual animal, it is recommended that the initial sentence identify the carcass to avoid any mistake in identification e.g., The carcass is that of an estimated 4-year-old, 8.5 kg., intact female, tricolor Beagle dog, ear tattoo N312, in good nutritional condition. The remainder of the necropsy report may be done in many ways. Often the order of the necropsy is followed in the write up as it may bring to mind more easily the lesions seen or it may be dictated directly at the necropsy table. Lesions are only described, not interpreted in the main text. Following the written report, it is often advisable to list the interpretations of the gross findings next to the organs involved. This is best done by a trained pathologist who should correctly interpret the lesions

and give the morphological diagnoses to the lesions found. Then the pathologist's summation of all findings in the case should be given as the gross diagnosis. A comment may follow to help clarify the case to the clinician. All lesions should be described as to location, color, size, shape, consistency and number or percent of involvement of a specific organ. The following relatively standard set of features should be noted to describe the changes seen at necropsy.

1. **Location:** Where on the skin, what part of the lung, etc.? The actual anatomical position, and its relationship to other organs and tissues (cranial, caudal, dorsal, ventral, left side, stomach, right adrenal). Even a lousy hand drawn picture may be of more value here than the word description.

2. **Color:** Use of the primary colors is best with shades and degrees as needed. Some people have never seen a green apple or any apple. All oranges are not orange. Mauve and pastels are difficult to interpret. Dark, brilliant, light, pale, mottled, streaked or stippled may apply.

3. **Size:** Only metric units should be used. Your necropsy knife handle should be marked every 1/2 cm so that you have an instantly available measuring device. Be objective. A grapefruit grown in Maine won't be as large as one grown in Florida, etc.

4. **Shape:** Use descriptive terms such as ovoid, round, conical, flat, nodular, lobular, tortuous, discoid, punctate, bulbous, wedge-shaped, fusiform, laminated, clustered, lace-like, straight-edged, etc.

5. **Consistency and Texture:** A most important feature of lungs; palpation is the key and sometimes even physical manipulation, such as actual bone breaking at the necropsy table, is helpful. Soft (lips), firm (nose) and hard (forehead) as well as fluctuant, gas-filled, friable, viscous, mucoid, gelatinous, stringy, turgid, dry, inspissated, caseous, crepitant, adhesive, gritty, granular, pliable, homogeneous, etc. may be used.

6. **Number and Extent (%):** As we can all count at least to 10 or 12, then do so. Do not use the words "few" or "several". Use dozens or hundreds in cases that apply. In cases of pneumonia, liver disease, or where portions of a large organ are

affected, the extent of involvement given in % is of great judicial significance. Many animals may have one whole lung (50%) involved and still be clinically normal.

7. **Content:** Quantity and nature of content in any cavity, natural or pathological is described in volumetric terms as well as the proper color, odor, consistency and shape of the content itself. The content description of the G.I. tract is of value and especially so for medicolegal cases, as is the content of the uterus, even in normal animals. Stricture or collapse of these may require such terms as patent, dilated, partially obstructed, obliterated, narrowed (including degree of narrowing), branched, communicating, tortuous, etc. with respect to their lumen.

In addition to the above standard set of features to be noted about each lesion, the necropsy report should include, when applicable, comments on:

(1) **Odor:** This is one of the hardest features to evaluate, but it is often quite diagnostic and by necessity is described in relation to well known odors. For example, similar to rancid butter, cider, onions, etc.

(2) **Distribution and Surface Appearance:** Focal or multifocal, locally extensive or diffuse covers many conditions while total, scattered, streaked and laminated are useful. Ulcerated, hairy, smooth, depressed, irregular, eroded, pitted, elevated, glistening, dull, scaly, membranous are of much value for surface descriptions.

SAMPLE NECROPSY REPORT

P.M.# N88-36

This is the carcass of a 41 kg., 1-2 year-old female, Suffolk sheep in poor nutritional condition with no appreciable autolysis and minimal body fat stores. A yellow plastic eartag #57 is present in the left ear. The oral and nasal mucosa are pale grey and the conjunctiva and vaginal mucosa are pale white. Only a small amount of fecal staining is present in the wool of the perineum and escutcheon.

There is a moderate amount of clear, gelatinous tissue in the ventral cervical subcutis and about 150 cc of clear, light-yellow, watery fluid in the abdominal cavity and 30 cc of similar fluid with 4 fibrin clumps in the pericardial sac.

The lungs are diffusely wet and mottled bright red. There are seven, 0.2 cm spherical nodules and six, 0.2 x 0.5 cm elongate, dark-grey nodules scattered in the dorsal caudal right lung lobe.

The liver is diffusely pale. The kidneys have numerous, about 50, 1 x 1 mm white foci scattered in their outer cortices. Four tapeworms, 30-50 cm x 10 x 0.2 cm, are in the ileum. The abomasum has only two, thin, 1 x 10 mm worms present. The fore-stomachs are normal as to content. No appreciable content is in the entire intestinal tract. Numerous, 50-100, grey-white, circumscribed, 0.25-0.5 cm, irregular, hard, gritty nodules are scattered in the cecal wall and serosa.

The animal is not pregnant.

No gross lesions are present in the brain or spinal cord.

GROSS FINDINGS:

Body as a whole - Emaciation; anemia

Abomasum - Endoparasites, *Hemonchus* sp.

Ileum - Endoparasites, *Monezia* sp.

Cecum - Chronic endoparasitism, *Esophagostomum* sp.

Lung - Terminal edema; chronic multifocal pneumonia,

Protostrongylus sp., presumptive

Pericardial sac - Hydropericardium

Peritoneal cavity - Ascites

Subcutis, ventral neck - Edema

GROSS DIAGNOSIS:

Emaciation

Chronic Endoparasitism

Note - A basic husbandry problem with nutrition and parasites is suspected.

The Pneumonias

If it's not firm it's probably not pneumonia.

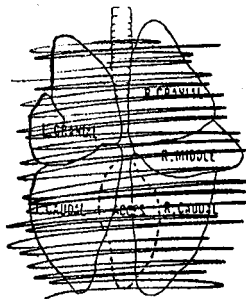
There is no such thing as pulmonary congestion and edema without a cause. i.e. - If you can't find a good reason for it, then it's probably just a terminal artifact.

Cattle and sheep inhale up to 80% of eructated rumen gas, and thus this may be a source of toxic chemicals.

Distribution of Lesions: Three major types that may overlap or even coexist.

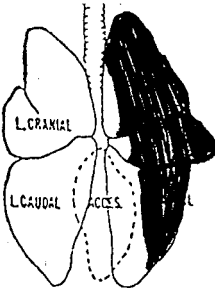
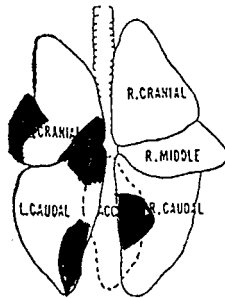
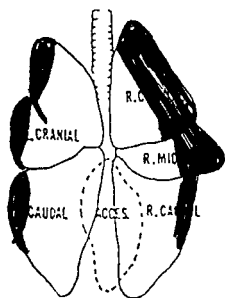
Diffuse: Affects the entire lung or a scattered major share of it. (80-90%).

Examples: Proliferative pneumonia
Toxoplasmosis
Heart Failure Lung
Anaphylaxis (bovine)



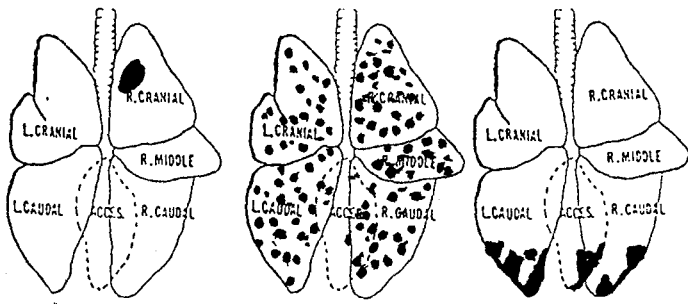
Locally Extensive: A large confluent area or several large confluent areas are affected and usually involve several to many adjacent lobules.

Examples: Pasturella pneumonia
Hemophilus pneumonia
Most inhalation (fluid) pneumonias
Most distemper pneumonias
Mycoplasma pneumonia
Pneumocystosis



Focal or Multifocal: Scattered individual or many small, usually discrete, foci throughout the lung or as demonstrated by a vascular or airway spread.

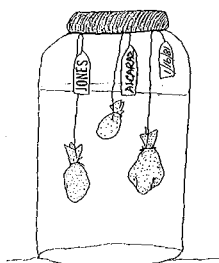
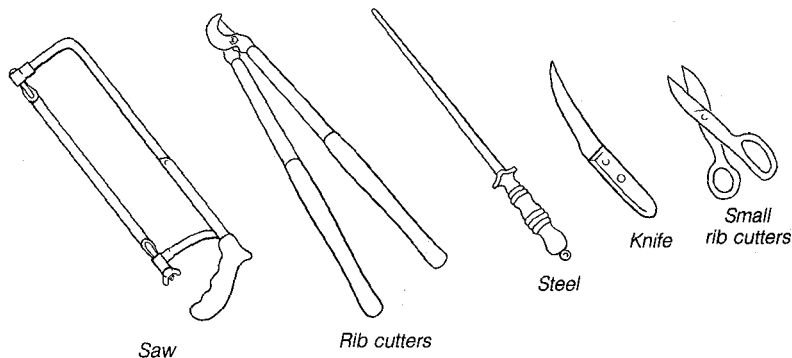
Examples: Embolic abscess shower
Dust inhalation
Most lungworms
Single foreign body



GROSS PATHOLOGY AND NECROPSY TECHNIQUES

All animals are placed on their left side with the dissector facing the animal's abdomen. As this technique is demonstrated with a normal animal it is expected that common sense variations will have to be used when one encounters abnormalities (lesions) or various physiological states such as pregnancy. Although the horse is the model in this text, the major procedures are applicable to most species. Variations in techniques are noted where necessary.

Wet the necropsy table surface to prevent adhesion of blood and other fluids. Read the history for indications of special techniques and care to be taken during the necropsy. Rubber gloves are required for all necropsies. Use at least ten times the volume of 10 percent formalin to the volume of tissue taken for histopathology. Label the tissue bottle or other containers prop-



10% formalin with 10 times volume of formalin to tissue samples from several animals being fixed at same time to conserve solution.

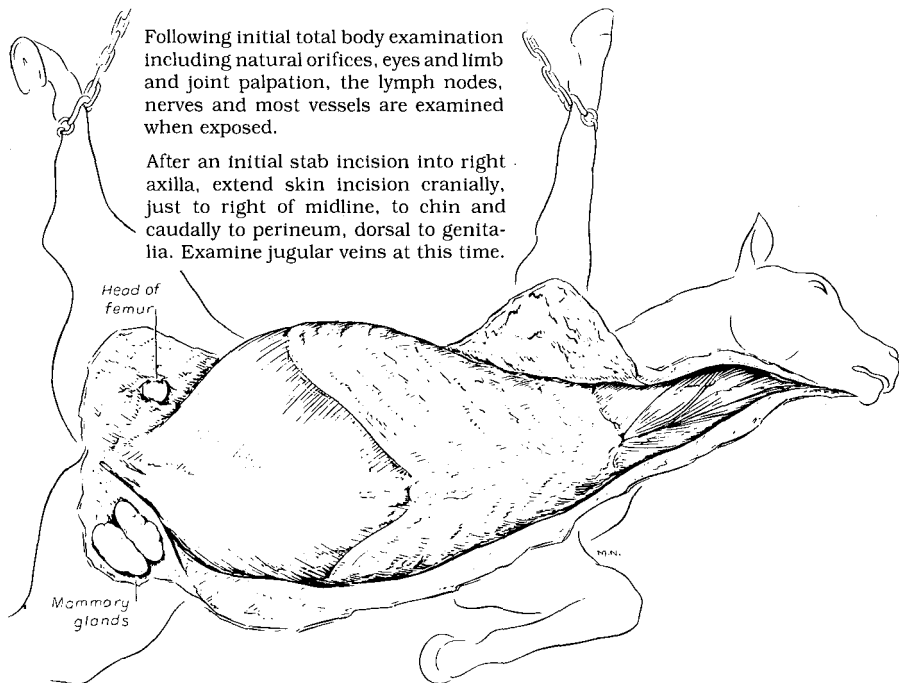


Individual properly labeled (name and date) tissue samples for sending to laboratory after proper fixation in large volume of fixative for fast, good fixation. It may now be sent with minimal fluid or just formalin soaked cotton to keep it moist.

erly. Routinely take tissue samples of liver, kidney, lung and all lesions. Brain sections are indicated in a grossly negative necropsy. Sections should be no more than 1/4 inch (0.5 cm.) thick. When taking sections for histological study from paired organs, make the left side pieces longer or larger (not thicker) for easier identification later when being trimmed or described to pathologists. As in any technique description, experience is needed to increase proficiency. Use of the carcass itself as a cutting board is recommended to prevent dulling the knife. To prevent cutting hair and thereby dulling the knife, the one stab wound into the axilla is the only time the knife cuts hair as the skin is reflected by cutting the subcutaneous tissue with the back of the blade towards the carcass.

Following initial total body examination including natural orifices, eyes and limb and joint palpation, the lymph nodes, nerves and most vessels are examined when exposed.

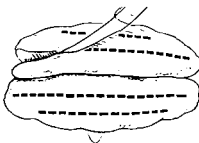
After an initial stab incision into right axilla, extend skin incision cranially, just to right of midline, to chin and caudally to perineum, dorsal to genitalia. Examine jugular veins at this time.



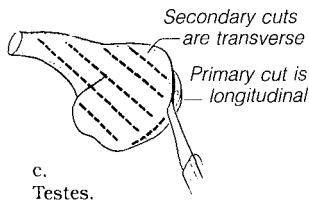
Reflect skin on right side and completely abduct right limbs by cutting muscular attachments of scapula and freeing femoral head. Reflect mammae or free each testicle separately and make sure to examine the right mamma or right testicle or any right-sided organ of paired organs before the left to help make recollection of which was the affected organ when time for write up comes. Cut open sheath. Cut back skin for short distance to left of midline.

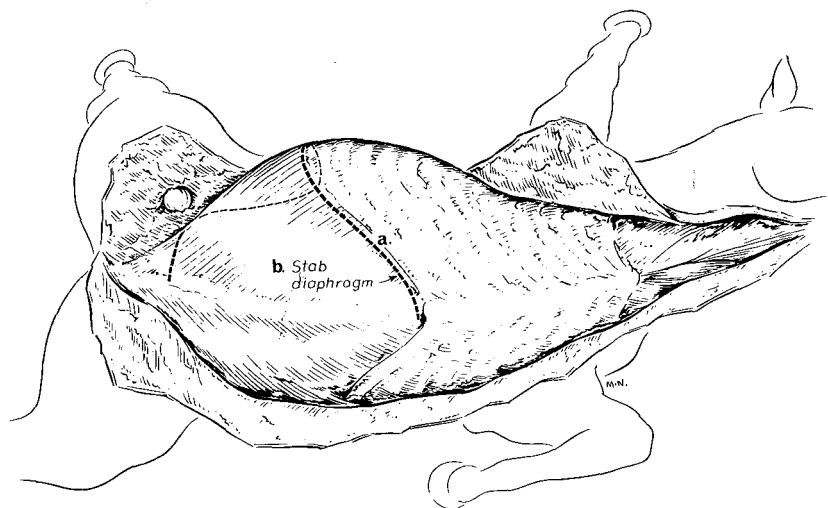


a.
When cutting back skin, use belly of knife towards skin, back of knife to body.



b.
Incise all sections of mammae to teat canals.

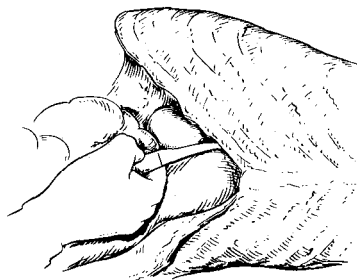




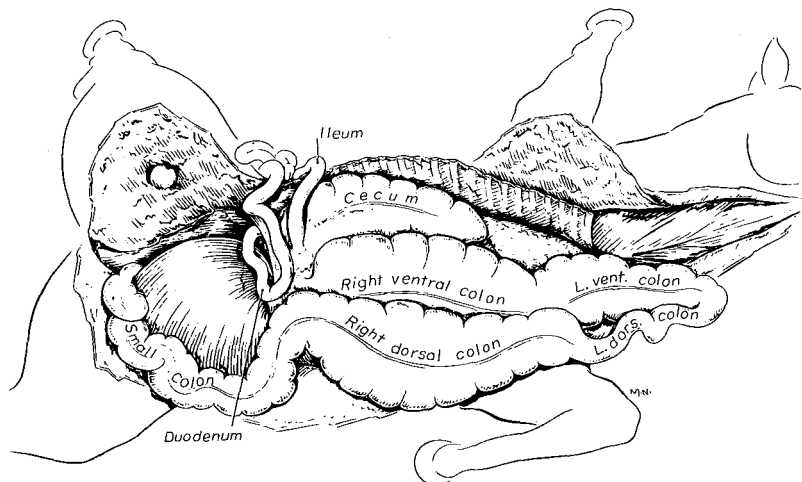
Incise along costal arch and dorsal flank down and across pelvic rim. Reflect this flap and examine abdominal cavity and viscera.



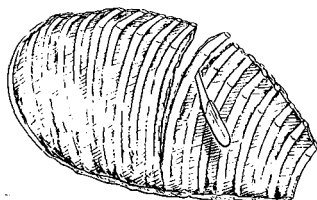
a.
Use belly of knife.
Pull up abdominal wall to prevent
cutting viscera.



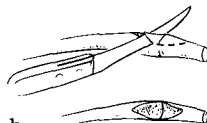
b.
Stab diaphragm near sternum and note
inrush or absence thereof of air as lungs
collapse. Cut entire right side of diaphragm
along costal arch and observe thoracic cav-
ity and viscera.



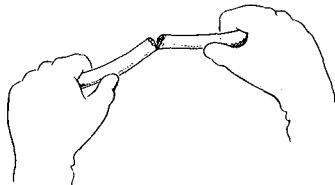
Remove ribs by cutting with rib cutters or saw, first close to sternum, then several inches from vertebrae. Check presence and position of all organs. Arrange G.I. tract to display all parts. In the **horse** place cecum dorsocranially, small colon on left thigh, large colon cranially, and small intestine over right flank. In **cattle** and **sheep** place small intestine and colon over right lumbar area, leaving forestomachs and abomasum in place. Examine but leave pancreas attached to duodenum or root of mesentery.



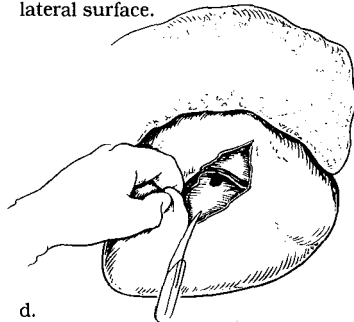
a.
Free a central rib by cutting off adjacent soft tissue close to bone.



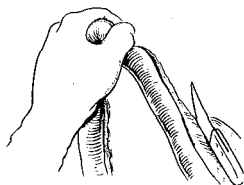
b.
Check costochondral junction of young animals by cutting along the thin edge cranially or caudally and **not** the flat medial (pleural) or flat lateral surface.



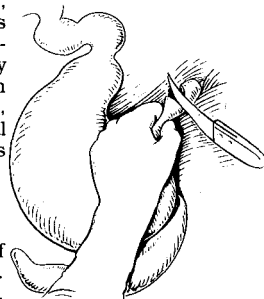
c.
Break or attempt to break rib against curvature for test of general bone strength.



d.
In situ open pericardium and examine pericardial contents.

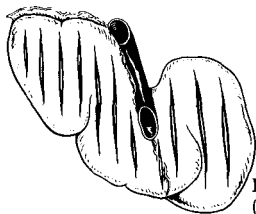
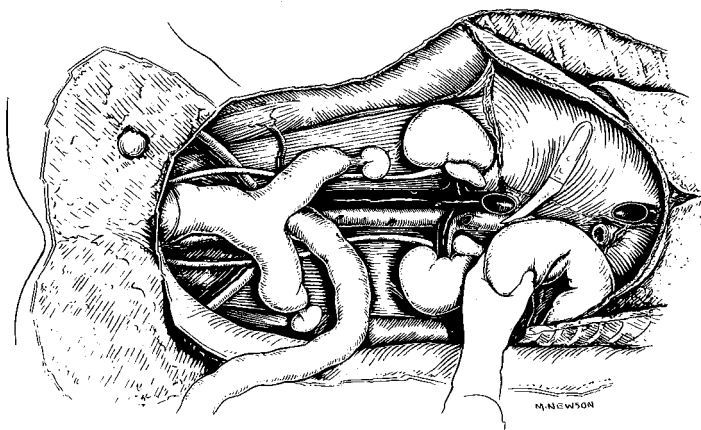


a.
Intestines can be easily stripped out without cutting in some species (dog, cat, sheep) but cut mesenteric attachments close to the bowel in others. Free the remaining G.I. tract from the dorsal body attachments by careful, blunt dissection and some cutting (bile duct, ligaments, etc.). In ruminants, grasp dorsal caudal blind sac of rumen and pull forestomachs free of body towards the prosector.



b.
Remove stomach by pinching off cardia and transecting esophagus. Spleen comes out with stomach. Detach spleen.

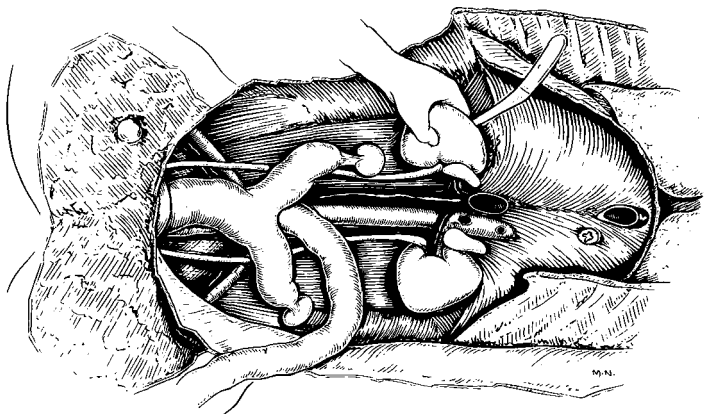
c.
Make several inspection slices into spleen.



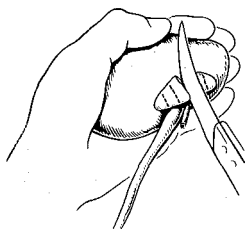
d.
Remove liver leaving diaphragm in place. Incise and inspect gall bladder in appropriate species. Make multiple inspection slices into liver and incise major vessels.

Remember: All sections for fixing should not be more than 1/4" (0.5 cm.) thick.

Caution: Do not scrape or squeeze sections to be taken for histological examination. Always take sections with sharp knife, never with a pair of scissors.



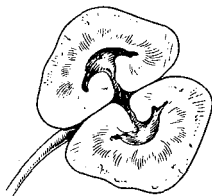
Remove kidneys separately leaving adrenals attached to kidneys.
Leave ureter attached to kidney and bladder.



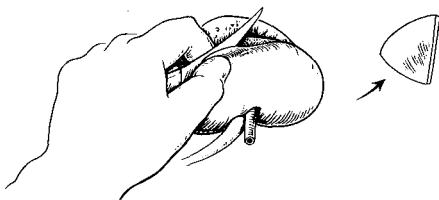
a.
Do not hold adrenal itself.
Incise adrenal.
Note cortex-medulla-cortex (CMC) ratio.



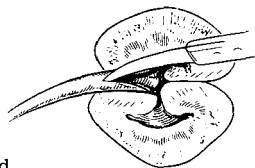
Roughly 1:2:1 in
this example.



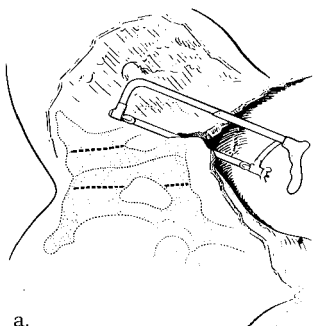
b.
Cut each kidney longitudinally
to the pelvis.



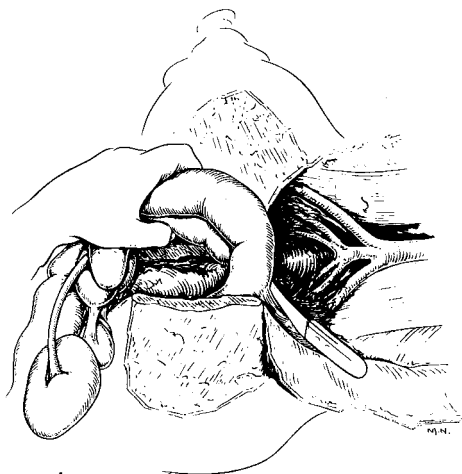
c.
Peel away capsule. Take tissue cross section
to include cortex, medulla and pelvic epithe-
lium. Make multiple transverse inspection
slices through organ.



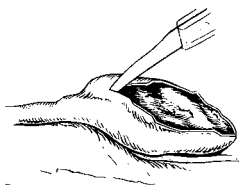
d.
Cut down ureter.
Do not detach from bladder.



a. Open pelvis by sawing (or using rib cutters) through pubis to obturator foramen, then through ischium, both sides. Remove symphysis.



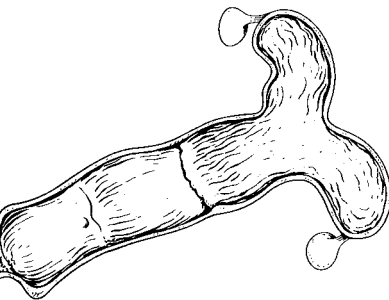
b. Cutting close to bone, remove pelvic viscera, kidneys with ureters and bladder, genitalia, and rectum.



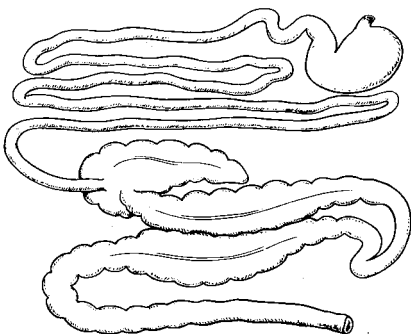
c. Open bladder and urethra.



d. Cut ovaries longitudinally then transversely.

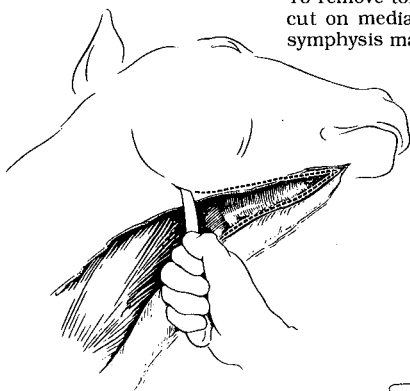


e. Open both horns of uterus, then cervix and vagina.

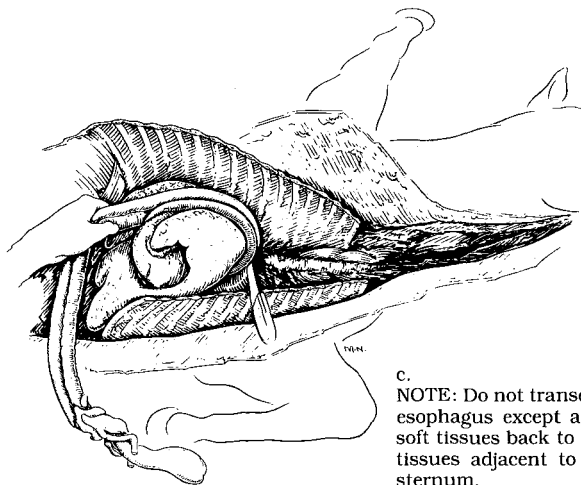
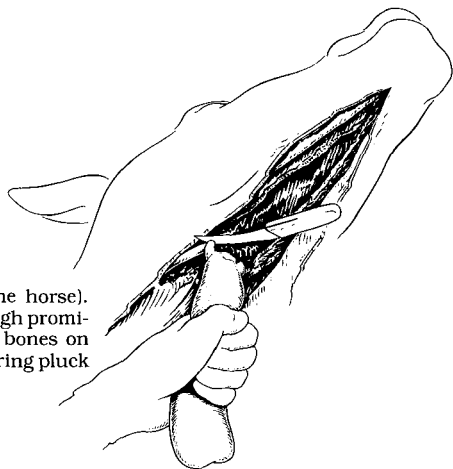


f. Lay G.I. tract in relative order to be opened as last major procedure of necropsy to prevent fecal contamination of tissues and instruments. (See Page 32)

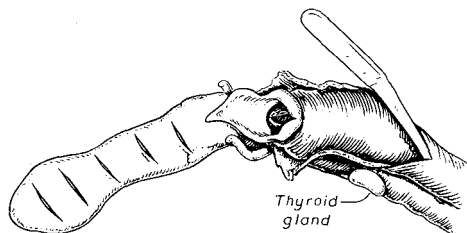
a.
To remove tongue, cervical and thoracic viscera *en masse*, cut on medial side of both mandibles close to bone. The symphysis may be split if necessary for easier removal.



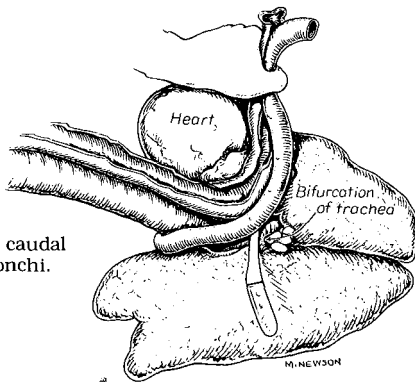
b.
Free tongue manually (difficult in the horse). Pull tongue down and back. Cut through prominent (kerato-epihyoid) joint of hyoid bones on both sides. Examine jugular veins during pluck removal.



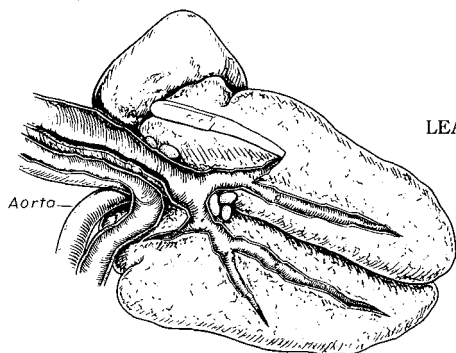
c.
NOTE: Do not transect aorta, vena cava or esophagus except at diaphragm. Free all soft tissues back to diaphragm by cutting tissues adjacent to vertebral bodies and sternum.



- a.
Examine tongue by transverse sections.
Observe and incise thyroids.
Observe parathyroids.
Cut down full length of esophagus.



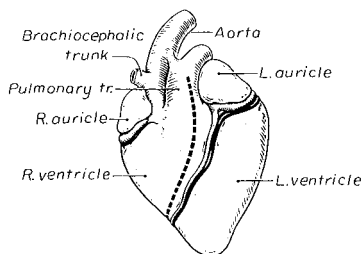
- b.
Free esophagus and aorta from dorsal caudal mediastinum to allow access to both bronchi.



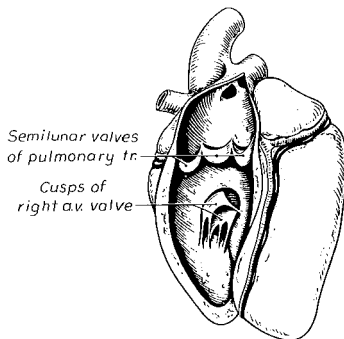
LEAVE HEART ATTACHED TO LUNGS.

- c.
Palpate lungs. Cut down trachea and major bronchi and observe cut ends of pulmonary arteries for emboli. Incise bronchial lymph nodes. To cut down and examine the pulmonary arteries, it is best to turn the lungs over and open from the ventral surfaces of the lungs.

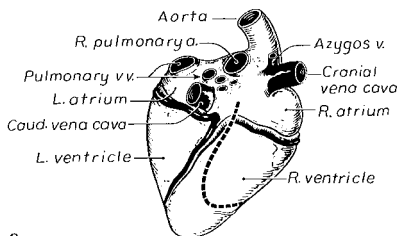
NOTE: Although shown isolated for better depiction in these drawings, it is wise to leave the heart attached to the lungs for best orientation and examination of major vessels and associated structures.



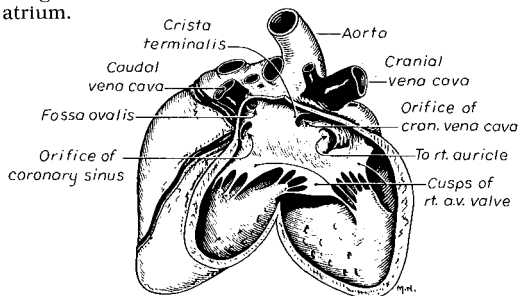
a.
To open right ventricle, hold heart in left hand with left side of heart towards you. Make incision, starting at pulmonary trunk, into right ventricle, close to interventricular septum.



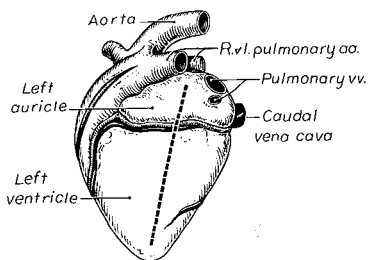
b.
Open pulmonary trunk past bifurcation. Check semilunar valves.



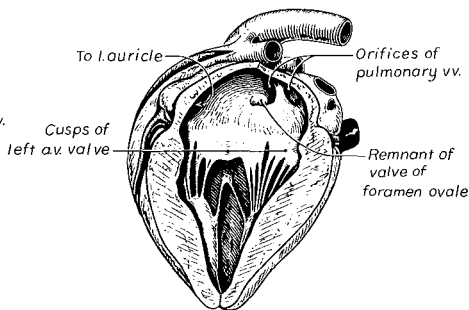
c.
Turn heart over with its right side towards you. Continue incision, following interventricular septum, into right atrium.



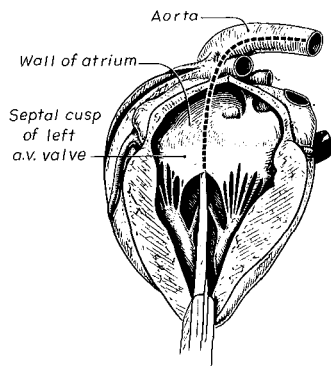
d.
Open right ventricle and atrium. Check right atrio-ventricular valve, orifices of cranial vena cava, caudal vena cava, fossa ovalis and coronary sinus.



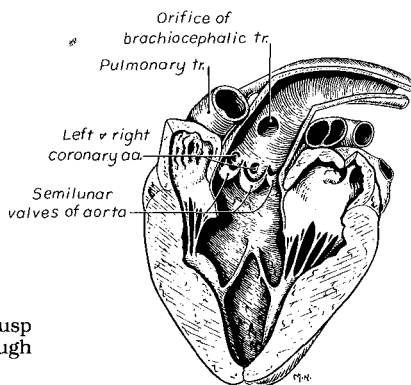
a.
Open left atrium and ventricle with straight incision. Incise through parietal cusp of left atrioventricular valve.



b.
Check left atrioventricular valve and openings to pulmonary veins.



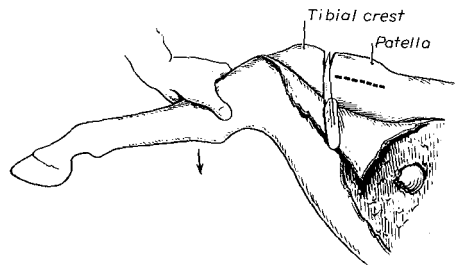
c.
To open aorta, insert knife under septal cusp of left atrioventricular valve. Incise through wall of atrium, out and down aorta.



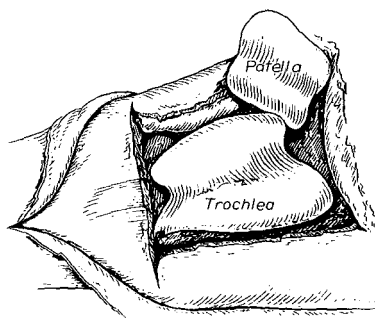
d.
Check semilunar valves of aorta, orifices and right and left coronary arteries, orifice of brachiocephalic trunk. Make multiple inspection slices through organ. Open abdominal aorta and its major branches (mesenterics, iliacs, etc.).

Five joints are routinely checked in the order given in the necropsy of most species, six in young animals.

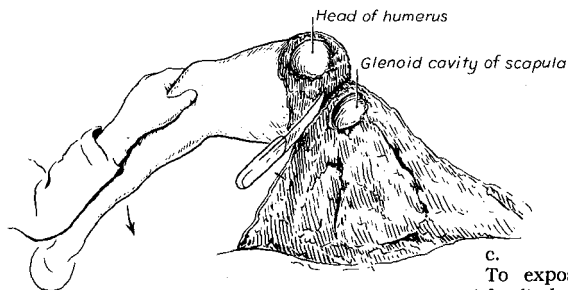
Right hip
Both stifles
Right hock (and left in young animals)
Right shoulder
Atlanto-occipital



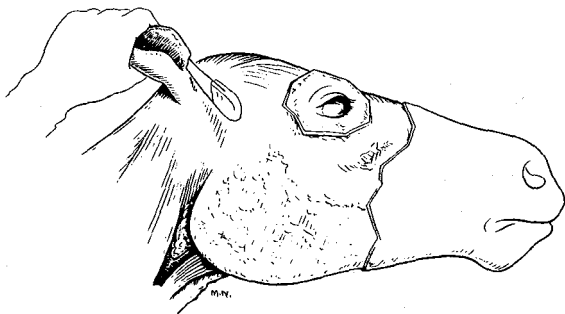
a.
To expose stifle joint, reflect skin, bend joint and cut patellar ligament 1/3 way up from tibial tuberosity.



b.
Incise along medial edge of trochlea.
Reflect patella.

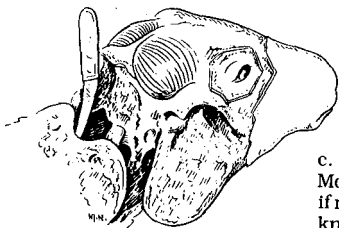
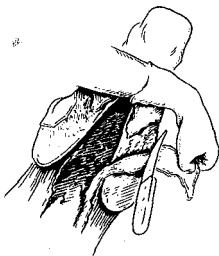


c.
To expose shoulder joint, bend forelimb down to raise joint. Cut on medial side at highest point.



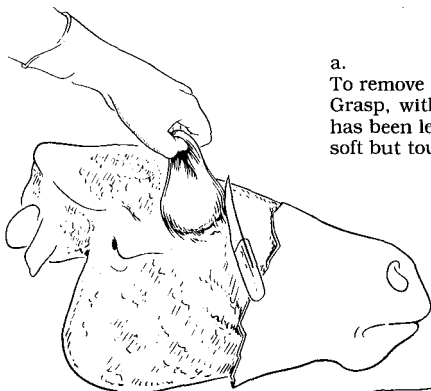
- a.
To expose atlanto-occipital joint and remove head, skin major portion of head and remove ears. Leave some skin around eyes.

- b.
Prop head up (hoist, knee, or assistant) to skin left (down) side of head.



- c.
Move head to locate joint. Obtain CSF at this time if required. Cut all soft tissues around joint. Insert knife into foramen, transect spinal cord and ligaments of joint dorsally and ventrally. Do not direct knife into brain proper. Remove head.

NOTE: Due to the apparent early degeneration of the eyes (retina), it is often recommended that eyeballs be removed and fixed before starting the rest of the necropsy.



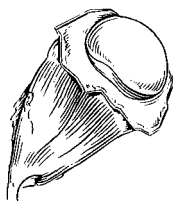
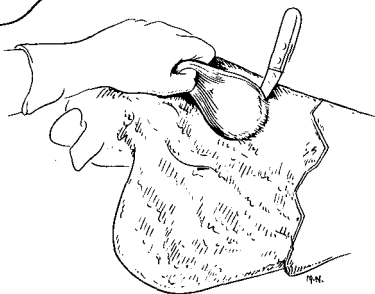
a.

To remove eye:

Grasp, with minimum traction, the skin which has been left around eye. With belly of knife, cut soft but tough tissues around orbit.

b.

Cut deeply around orbit, staying close to bone. Transect optic nerve.

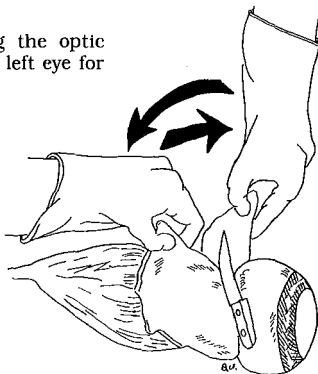


c.

Remove eye leaving the optic nerve longer on the left eye for easy identification.

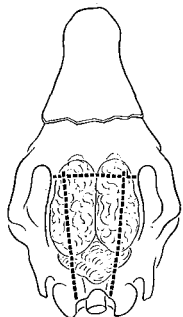
d.

Pull soft tissue back and forth under the knife blade while holding the back of the knife gently against the eyeball proper. Use the carcass as a cutting board.

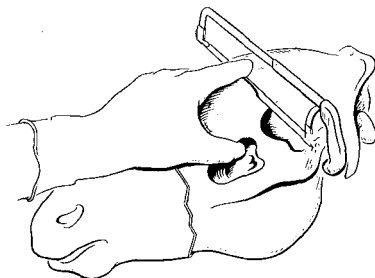


e.

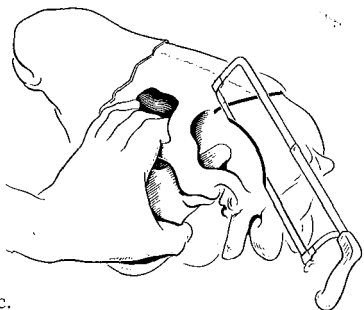
For proper fixation, fix the eyeball *en toto*. Some ocular pathologists prefer Bouins or Zenkers but due to their mercury content and its biohazard activity, formalin still does a good job if the eyes are fixed early.



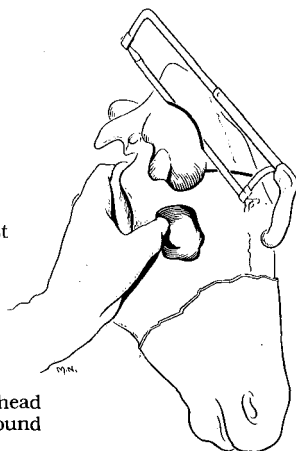
- a.
Diagram showing location of brain in dorsal view of skull.
Dotted lines represent lines of incision.
Remove major muscle masses from area of dotted lines.



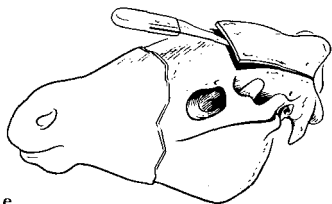
- b.
Hold head with thumb in eye socket, index finger on top of blade of saw. One cut is transverse through the frontal bone caudal to supraorbital process.



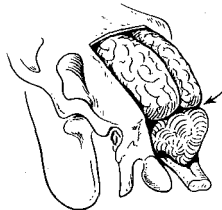
- c.
Place head on right side. Another cut is sagittal, just medial to left occipital condyle.



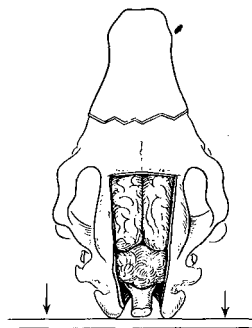
- d.
Place head on left side for one cut. Cranial part of head is toward you, thumb in eye socket, fingers around mandible.



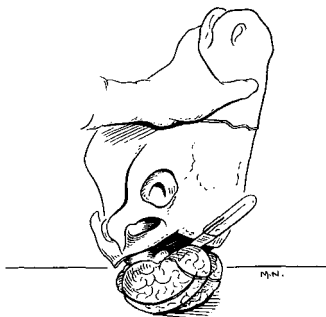
c.
Pry up skull cap. Use stronger prying material than knife if bone was not sawn free. Remove.



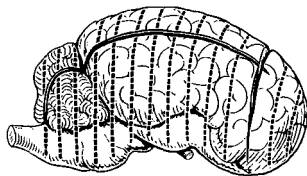
f.
Check to see that tentorium cerebelli (arrow) is removed as well as other limiting dura.



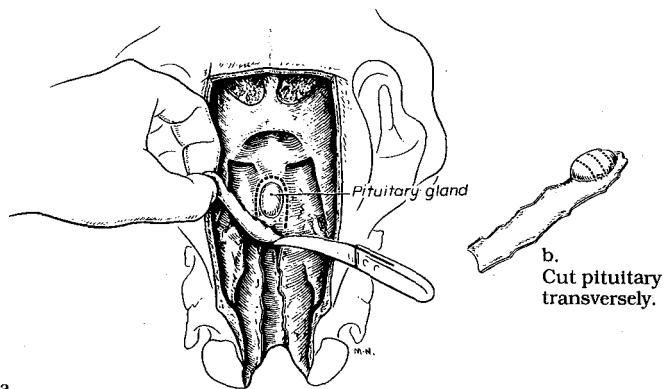
g.
With head in upright position, tap it lightly on table to loosen brain.



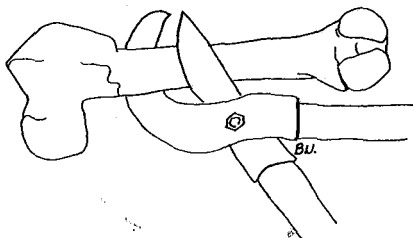
h.
Cut olfactory tracts and cranial nerves as brain is removed. Tilt head so that brain will **rest** on table.



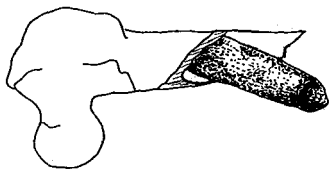
i.
If brain is not to be kept, cut in 1 cm. transverse sections for inspection.



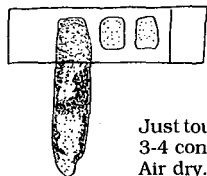
- a. To remove pituitary: Pick up dura on basioccipital between condyles.
Peel it forward to include pituitary.



To make a bone marrow impression smear or obtain a section of marrow, crack open almost any large bone of young animals or the ends of long bone in mature animals by using the rib cutters to obliquely crack the bone.



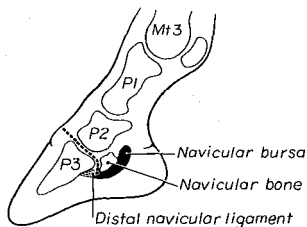
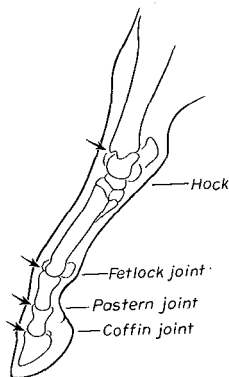
If area of bone marrow or other tissues used for touch preparation are too bloody, then touch the surfaces first with absorbant paper (paper towel) and then make the touch preparation. Remaining core can be put in formalin for fixation.



Just touch glass slide to red marrow at 3-4 contact areas. DO NOT SLIDE.
Air dry.

JOINTS EXAMINED IN SPECIAL CASES

Prior to checking distal joints on the limb, skin the leg to include removal of coronary band.

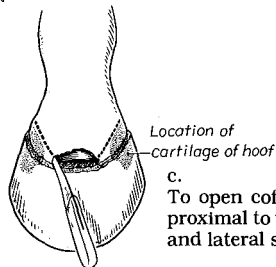


b. Diagram of section showing depth of incision at coffin joint.

a.

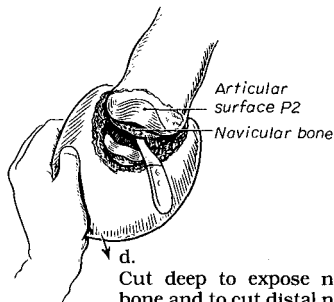
To check joints on hindlimb distal to stifle:

For reasons of leverage start at the coffin joint, then pastern, fetlock and tibiotarsal articulation of the hock.



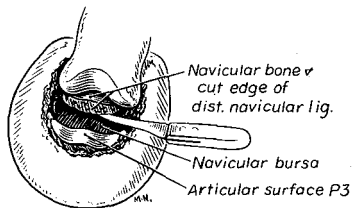
c.

To open coffin joint and examine navicular bursa, cut proximal to wall of hoof, first across front then on medial and lateral sides, deep to cartilage of hoof.



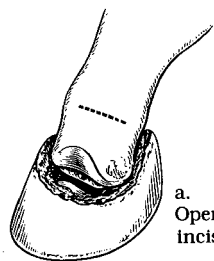
d.

Cut deep to expose navicular bone and to cut distal navicular ligament.

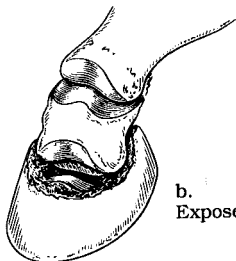


e.

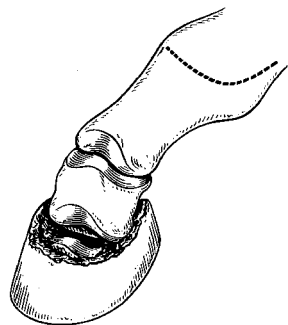
Raise navicular bone to expose bursa.



a. Open pastern joint with incision across front.



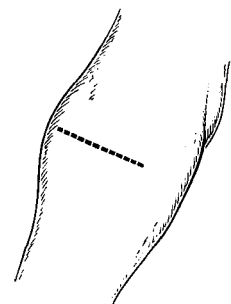
b. Expose joint.



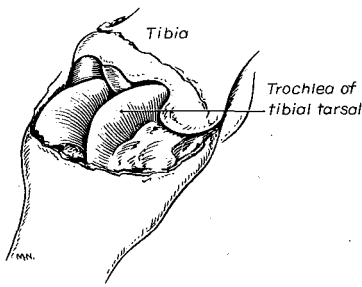
c. Open fetlock with incision across front of joint and up one side.



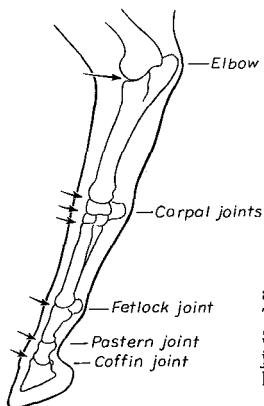
d. Expose joint.



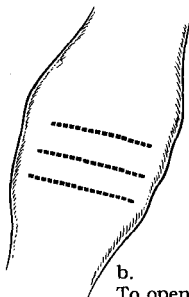
e. To expose tibiotarsal articulation of hock, cut across front of joint at distal end of tibia.



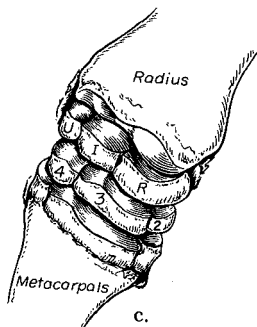
f. Expose joint.



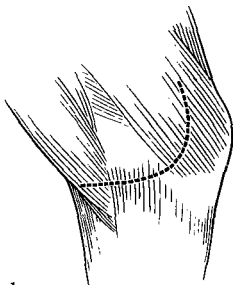
a.
To check joints of forelimb distal to shoulder:
Skin the limb. Again for necessary leverage, start at coffin joint. Procedures for opening the coffin, pastern and fetlock joints are the same as described for the hindlimb.



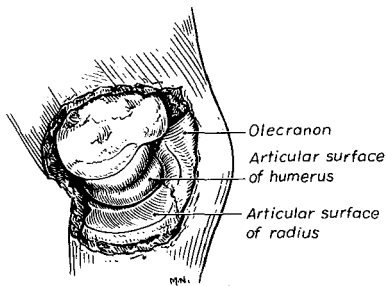
b.
To open carpal joints make three incisions: at distal end of radius, between rows of carpal bones, and at proximal end of metacarpals.



c.
Expose joint.

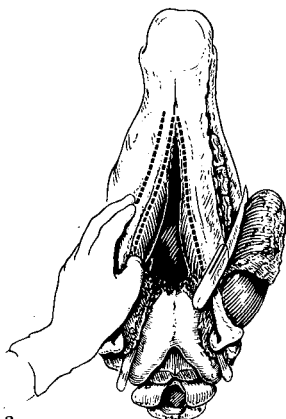


d.
To open elbow joint, go in from the medial side, incise around distal end of humerus.

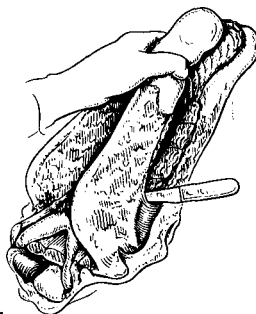


e.
Expose joint.

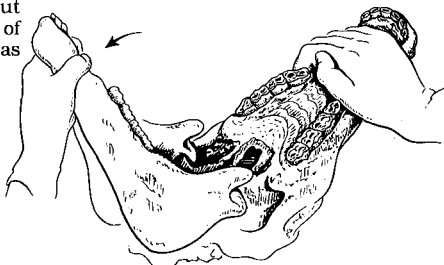
TO REMOVE MANDIBLE
(RARELY DONE)



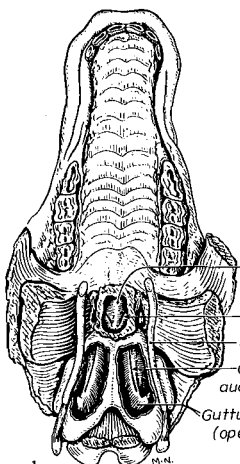
- a. With dorsal surface of head on table, cut all muscles on medial and lateral sides of both mandibles from cranial or caudal (as shown) position.



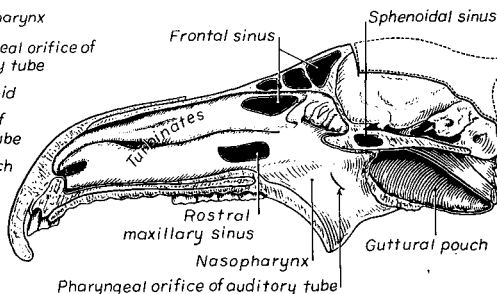
- b. Cut across pterygomandibular fold caudal to teeth.



- c. Pull back and free lower jaw.

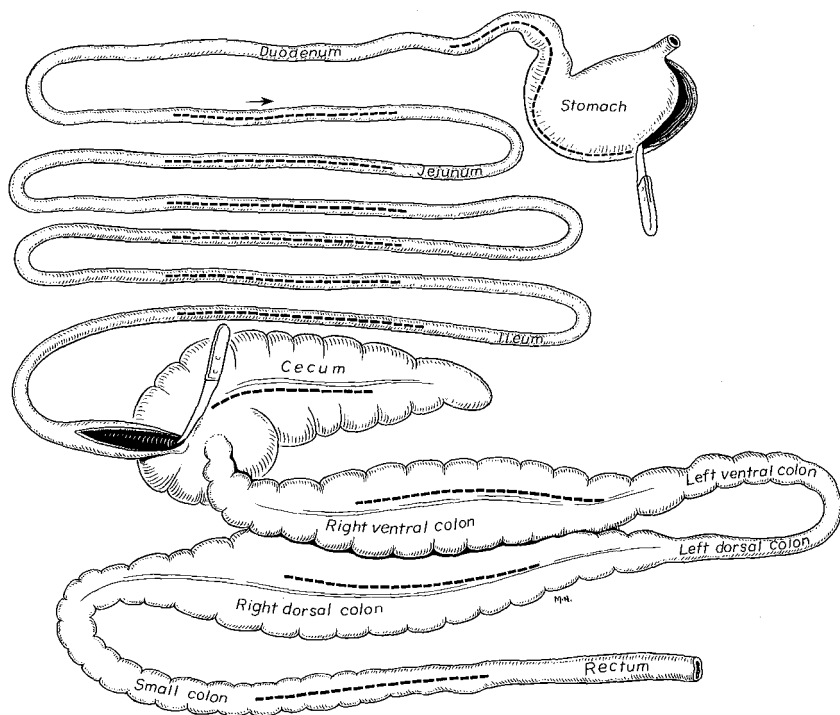


- d. Check guttural pouches.



- e. Saw head in two sagittally. Avoid front teeth (hard on saw blades). Remove nasal septum to check sinuses. Another transverse saw cut cranial to the premolars will eliminate cutting any teeth.

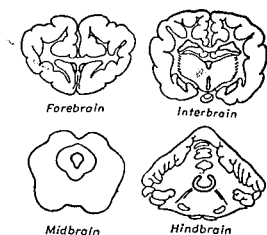
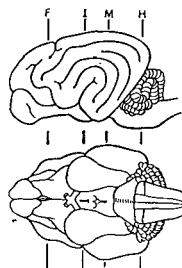
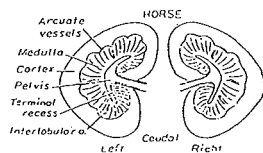
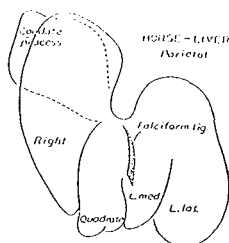
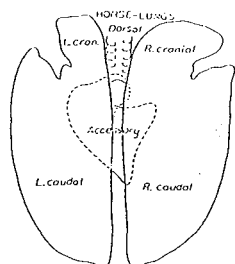
To check G.I. tract, cut along greater curvature of stomach, forestomach, and representative lengths of duodenum, jejunum, and ileum. Open ileocecal orifice and cecum, large and small colon and rectum. Incise major vessels when exposed.



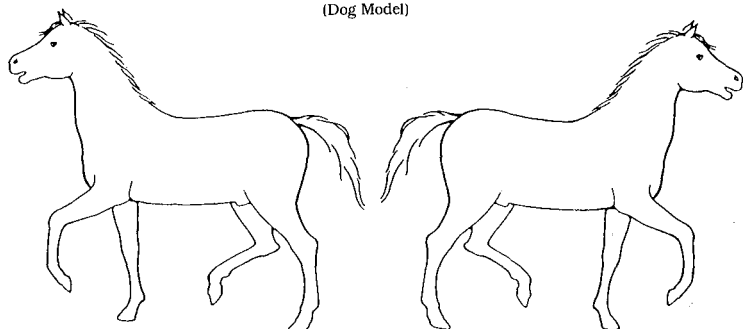
THE HORSE

Rough drawings for necropsy lesion localizations

"A picture is worth a thousand words."



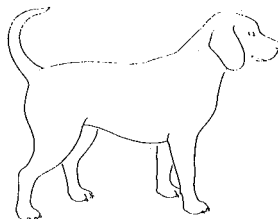
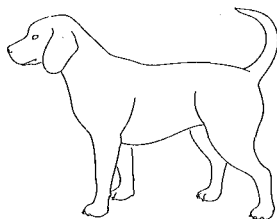
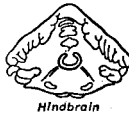
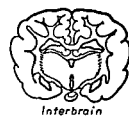
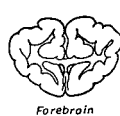
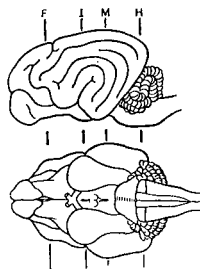
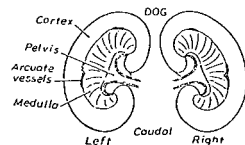
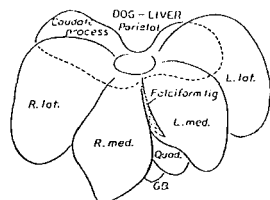
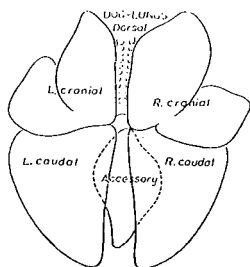
(Dog Model)



THE DOG

Rough drawings for necropsy lesion localizations

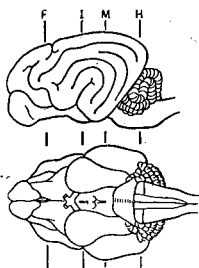
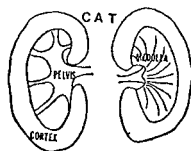
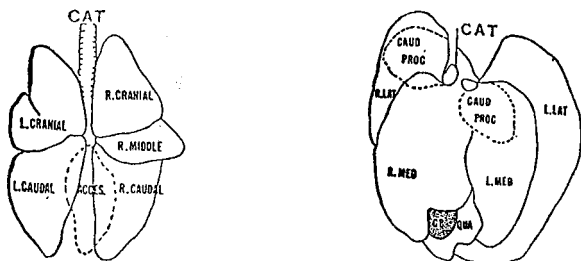
"A picture is worth a thousand words."



THE CAT

Rough drawings for necropsy lesion localizations

"A picture is worth a thousand words."



Forebrain



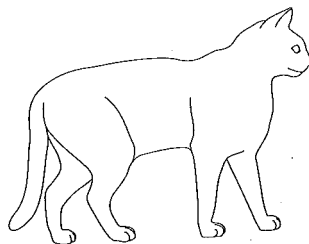
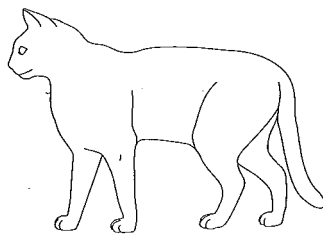
Midbrain



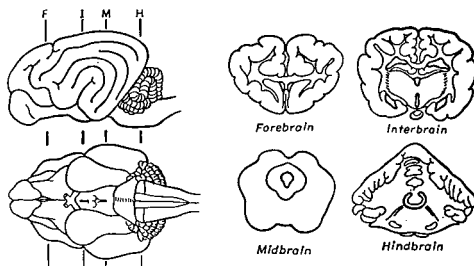
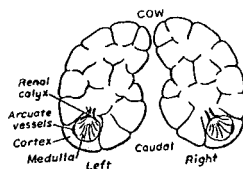
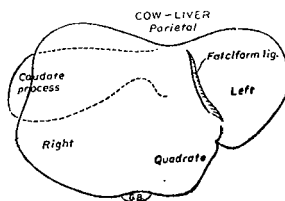
Hindbrain



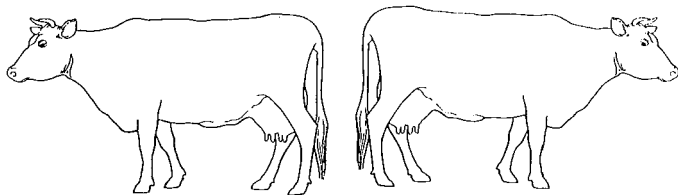
(Dog Model)



THE COW
Rough drawings for necropsy lesion localizations



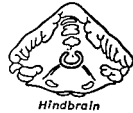
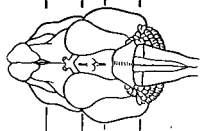
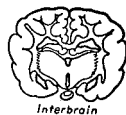
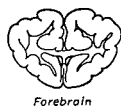
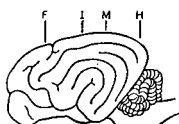
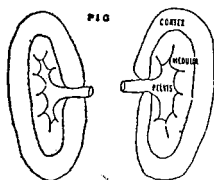
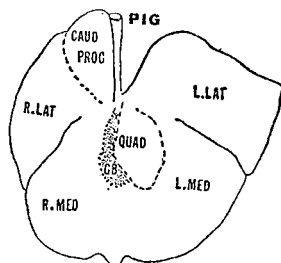
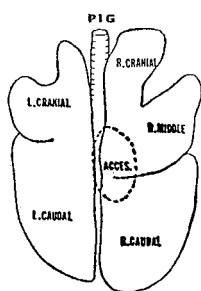
(Dog Model)



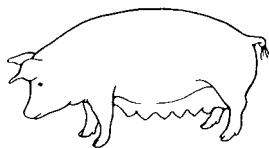
THE PIG

Rough drawings for necropsy lesion localizations

"A picture is worth a thousand words."



(Dog Model)



Note: This list, if learned, is almost guaranteed to increase the vocabulary of almost anyone. It's a necessity for anyone in the biological sciences.

LIST OF SOME OF THE MORE COMMON GREEK AND LATIN COMBINING FORMS

-(an)	L-without, not	collum-	L-neck	-gogue-	Gr-leading
ab-	L-from	conch-	Gr-a shell	gon-	Gr-angle-seed
acro-	Gr-extremity	corn-	L-horn	graph-	Gr-to write
ad-	L-to	cortico-	L-bark	haemo-	Gr-blood
adeno-	Gr-gland	cruci-	L-cross	hemi-	Gr-half
adipo-	L-fat	crypt-	Gr-hidden	hepta-	Gr-liver
ala-i	L-wing	cten-	Gr-comb	hetero-	Gr-different
alb-i-	L-white	cyan-	Gr-dark blue	hex-	Gr-six
-algia	Gr-pain	cyn-	Gr-dog	hippo-	Gr-horse
ambi-	L-both	cyt-	Gr-cell, hollow	histo-	Gr-tissue
amphi-	Gr-both	de-	L-down, from	homo-	Gr-same
amyl-	L-starch	dent-	L-tooth	horm-	Gr-to excite
an-	Gr-without, not	derma-	Gr-skin	hyalo-	Gr-glassy, clear
ana-	Gr-up	di-	Gr-double	hydro-	Gr-water
ankylo-	Gr-bent	dia-	Gr-through	hymen-	Gr-water
ante-	L-before	diplo	Gr-double	hypo-	Gr-under
anti-	Gr-against	dis-	L-down, from	in-	L-not, without
aqua-	L-water	duo-	L-two	in-en-	L-into
archi-	Gr-first	dura-	L-hard	inter-	L-between
arthro-	Gr-joint	duct-	L-convey	intra-	L-within
-ase	L-enzyme	dys-	Gr-bad, ill	iso-	Gr-equal
auto-	Gr-self	ectasis-	Gr-dilated	-itis	L-inflammation
bi-	L-two	ecto-	Gr-outside	lact-	L-milk
bio-	Gr-life	ella, us, us	L-diminutive	lacun-	L-pit, lake
blast-	Gr-germ, bud	-emia	Gr-blood	lamin-	L-layer, plate
bothri-	Gr-pit	endo-	Gr-within	leio-	Gr-smooth
brachi-	Gr-arm	ento-	Gr-within	leuco-	Gr-white
brady-	Gr-slow	entero-	Gr-intestine	lemma-	Gr-skin
brevis-	L-short	erythro-	Gr-red	lingua-	L-tongue
caec-	L-blind	ex-	L-out	lipo-	Gr-fat
capit-	L-head	extra-	L-beyond	lith-	Gr-stone
card-	Gr-heart	fenestra-	L-window	-logy	Gr-discourse
cata-	Gr-down	fer-	L-to carry, bear	-lysis	Gr-divide, destroy
cer-	Gr-horn	flav-	L-yellow	macro-	Gr-large
cervix-	L-neck	fug(s)-	L-flee	macula-	L-spot
chlor-	Gr-green	gamo-	Gr-marriage	mal-	L-bad, ill
choan-	Gr-funnel	gastro-	Gr-stomach	mast	Gr-breast
chrom-	Gr-color	-gen	Gr-to produce	medi-	L-middle
chyl-	Gr-juice	-glia	L-glue	mega-	Gr-large
chym-	Gr-juice	glossi-	Gr-tongue	mes-	Gr-middle
clast-	Gr-to break	glyco-	Gr-sweet, sugar	meta-	Gr-change, beyond
coel-	Gr-hollow	gnath-	Gr-jaw		

-meter	L-measure	ped-	L-foot	rhyngo-	Gr-snout
micro-	Gr-small	penta-	Gr-five	rostri-	L-beak
mono-	Gr-single	peri-	Gr-around	rumin-	L-throat
morph-	Gr-form	petro-	Gr-stone	saggitta-	L-arrow
morti-	L-death	phago-	Gr-to eat	salpi-	Gr-trumpet
myi-	Gr-fly	phil-	Gr-loving	sacro-	Gr-flesh
myo-	Gr-muscle	phlebo-	Gr-vein	sapro-	Gr-putrid
myelo-	Gr-marrow	phon-	Gr-voice, sound	scalar-	L-ladder
myxo-	Gr-mucus, slime	phot-	Gr-light	schizo-	Gr-cleft
	Gr-dead	phyll-	Gr-leaf	sclera-	Gr-hard
necro-	Gr-thread	phyto-	Gr-plant	scoli-	Gr-bend
nemo-	Gr-new	pia-	L-tender	-scope	Gr-see
neo-	Gr-kidney	plasm-	Gr-formed	scut-	L-a shield
nephro-	Gr-nerve	platy-	Gr-flat	seb-	L-tallow
neuro-	L-nest	pleo-	Gr-more	sect-	L-to cut
nid-	L-black	pleuro-	Gr-side	sella-	L-saddle
nigr-	Gr-night	pneumop	Gr-lung	semi-	L-half
noct-	Gr-back	pnoi-	Gr-breath	sept-	L-a wall
noto-	L-nut	pod(i-o)	Gr-foot	septic	L-putrid
nucleus	L-naked	poly-	Gr-many	serra	L-a saw
nud-	Gr-to prick	pons-	L-bridge	seti-	L-bristle
nyssus-	L-small eye	porta-	L-gate	sialo-	Gr-saliva
ocell-	L-eight	post-	L-after	siphon-	Gr-tube
oct-	Gr-tooth	pre-	L-before	siphuncal-	L-small tube
odout-	Gr-like	pro-	Gr-before	soma-	Gr-body
-oid	Gr-few	proct-	Gr-anus	Somn-	L-sleep
olig-	Gr-tumor	proto-	Gr-first	sperm-	Gr-seed
-oma	Gr-eye	psalter-	Gr-book	spheno-	Gr-wedge
-omma	Gr-eyel	pseudo-	Gr-false	splanchno-	Gr-viscera
omphalc-	Gr-navel	psor-	Gr-itch	squam-	L-scale
oneh-	Gr-barb	psych-	Gr-breath, soul	stat-	Gr-standing
oo-	Gr-egg	psyll-	Gr-flea	stelle-	L-star
opercul-	L-a cover	ptero-	Gr-wing	steno-	Gr-narrow
ophthalm-	Gr-eye	ptyl-	Gr-saliva	stereo-	Gr-solid
opisth-	Gr-behind	pulic-	L-flea	sterco-	Gr-dung
or-, os-	L-mouth	pulmo-	L-lung	tetho-	Gr-breast
orchid-	Gr-testicle	pupa-	L-baby	stigma-	Gr-point
ortho-	Gr-straight	pyl-	Gr-gate	stoma-	Gr-mouth
-ose	L-sugar	pyo-	Gr-pus	strati-	Gr-layered
ossi-	L-bone	pyri-	L-pear	strepto-	Gr-turned
osteo-	Gr-bone	quadr-	L-four	stria-	L-furrowed
osti-	L-door	rachi-	Gr-spine	strongylo-	Gr-round
ot(o)	Gr-ear	ram(i)	L-branch	stylo-	L-column
oxy	Gr-sharp	re-	L-again	sub-	L-under
pachy-	Gr-thick	rect-	L-straight	super-	L-over
palaeo-	Gr-ancient	ren-(i)	L-kidney	supra-	L-above
pan-	Gr-all	ret-(a-i)	L-net	sym-	Gr-together
par-	L-to beget	rhabdo-	Gr-a rod	syn-	Gr-together
para-	Gr-beside	rheo-	Gr-to flow	syringo-	Gr-pipe
pariet-	L-wall	rhino-	Gr-nose	tachy-	Gr-rapid
path-	Gr-disease	rhizo-	Gr-root	tact-	L-touch

taen-	Gr-ribbon	trachel-	Gr-neck	uro-	Gr-urine
ov(i)	L-egg	trachy-	Gr-rough	vaso-	L-vessel
tapet-	L-carpet	tremat-	Gr-hole	ven-	L-vein
tale-	Gr-far,end	tri-	Gr-three	ventr-	L-belly
tenui-	L-thin	tricho-	Gr-hair	vermi-	L-worm
terato-	Gr-monster	troch-	Gr-pulley	vesicul-	L-blister
tetra-	Gr-four	trombid-	Gr-timid	via-	L-way
thalam-	Gr-chamber	trop-	Gr-turning	villi-	L-shaggy
theco-	Gr-case,	trophy-	Gr-nutrition	vita-	L-life
	covering	trypano-	Gr-an auger	vitri-	L-glassy
theli-	Gr-nipple	tumor	L-swelling	vivi-	L-alive
therio-	Gr-breast	tunic-	L-a garment	vora-	L-to devour
thermo-	Gr-heat	tympano-	Gr-a drum	xantho-	Gr-yellow
thromb-	Gr-clot	tyro-	Gr-cheese	xero-	Gr-dry
thyro-	Gr-door,shield	ultra-	L-beyond	xylon	Gr-wood
thysan-	Gr-fringe	unci-	L-hook	zoo-	Gr-life,animal
tok-	Gr-birth	-uncula	L-little	zygo-	Gr-yoke
tomo-	Gr-to cut	unguli-	L-hoof	zym-	Gr-ferment
tox-	Gr-a bow	uni-	L-one		
trabecul-	L-a small beam	uro-	Gr-tail		

Nonlesions

A. General and external findings

1. **Bloody Nasal Discharge:** A common postmortem (P.M.) artifact usually due to nasal congestion at death with P.M. vascular rupture of congested vessels. This needs to be differentiated from real hemorrhage from nasal lesions as tumors and pulmonary hemorrhage associated with pneumonia or pulmonary artery rupture in cattle with pulmonic abscesses associated with ruptured liver abscesses earlier. In simple stomach animals, gastric reflux after death may allow gastric fluid to erode small nasal vessels.
2. **Gastrointestinal Nasal and/or Oral Discharge:** Common finding even early after death with gastric sphincter relaxation and later with abdominal gas or carcass handling causing the discharge.

3. **Rectal or Vaginal Prolapse:** P.M. artifacts usually due to gas distention of abdominal viscera. More likely to be seen earlier in animals on highly fermentable feeds and may be easily confused with antemortem bloat. Often portions of prolapsed tissues are eaten by scavenger rats, dogs, birds and rodents and sometimes so cleanly removed that surgical removal has been considered by the unwary prosector.
4. **Livor Mortis:** Alive, we have blood relatively evenly distributed in our bodies but after death, the still fluid blood may distribute itself according to the laws of gravity with the more dependent portions being suffused with more blood causing both a differential in weight of paired organs and a more red bloodier organ. With early P.M. blood clotting, it may not be so readily apparent, if present at all, as the clots themselves prevents redistribution. Some external tissues, as the pale skin of pigs themselves, show distinct patterns on its surface mimicking the variations in the surface it died on. The same variations may be seen on the liver, lungs, heart and kidneys where ribs or adjacent organs may be pushed against the organ and thus keep the blood from pooling in the area pushed upon which would then be paler than surrounding areas.
5. **Melanosis:** This is the dark grey to usually black normal pigmentation of various tissues due to the deposition of melanin in almost all species. It would not be in albinos. It is commonly seen in the pulmonary artery and aorta of sheep, brain, meninges, adrenal, uterus, trachea, kidneys, oral cavity and esophagus of most other species. It may diffusely discolor an organ which may cause some confusion with a melanoma.
6. **Pseudomelanosis:** This is seen in all species as areas of grey to black discoloration of the tissues due to postmortem decomposition of blood by bacterial action forming

hydrogen sulfide. It can occur amazingly quickly after death in some tissues as the gut. It is most commonly seen on the kidneys, liver or spleen in contact with the gut and in the gut wall itself.

7. **Pseudoicterus of Horses:** The tissues of young horses and almost any dehydrated horse have the tendency to be more yellow than normal. The skin, mucous membranes and articular cartilages are not stained as in true icterus due to bilirubin pigment. Pseudoicterus is a relative increase of normal blood pigments including carotene. This relative term could even be used to describe the increase of normal color of certain cattle breeds as the Guernsey and Jersey.
8. **Enlarged Lymph Nodes of Youth:** Young animals often surprise the uninitiated prosector by the relative increased size of their essentially normal lymph nodes. Only local nodes may be enlarged or all the nodes may be relatively enlarged. The nodes of the gastrointestinal tract, especially, are often fairly large in calves.
9. **Injection Sites:** Tan, dry-appearing material with fluid and fibrin in the pleura or heart sac having a medicinal (alcohol) odor may be from a barbiturate or other euthanasia solution injection. A greenish, watery focus surrounded by dry heart muscle may indicate an intracardiac injection. Again, the odor may help here. The heart blood itself may be granular, clumped and often brownish.
10. **Thoracic Inlet Pseudomalignant Edema:** Especially in cattle but to a lesser degree in pigs, sheep and horses one may commonly find moderate to marked edema and emphysema at the thoracic inlet, neck and anterior shoulder region in moderately to severe autolyzed carcasses. One may even find on smear and culture, many Clostridia and the tissue may have a slightly sweetish

odor like blackleg or malignant edema, but this is almost always just a postmortem change. It is often misdiagnosed as one of the clostridial diseases.

B. Spleen

1. **Splenic Capsule Defects:** These are seen mainly in the horse and appear as deep depressions, slits or folds in the parietal surface of the spleen primarily in its middle third. The involved surfaces of the defect are similar to the remaining splenic surface. These may also be seen commonly in pigs and cats. The splenic fold defects are often mistaken for previous traumatic lesions.
2. **Extruded Red Pulp:** A few to far too many to count tiny red 1-3 mm nodules of extruded red pulp through the capsule are commonly found in the foal and pig. They are often seen on the edge of the spleen but may be seen on any or all surfaces and even through the wall of the splenic vein. Wherever they are, they are covered by the overlying serosa or endothelium. This is an anatomical variation of no significance.
3. **Anesthetic Spleen:** These are moderately to enormously enlarged spleens which are very soft and when cut, blood flows freely from them. Anesthetic agents, especially barbituates in euthanasia solutions, cause this condition. It would be hard to differentiate this from acute torsion, but the easily flowing blood would help tell it from the splenomegaly of chronic bacterial infection, protozoal infection, passive congestion from vascular impairment and diffuse splenic neoplasia. The anesthetic enlarged spleens can be seen with other chemical agents like chloroform, but the opposite is also true that even with barbituate use, the spleen may not be enlarged.
4. **Pseudoinfarcts of the Spleen:** These are irregular focal areas of swollen spleen often with a straight edge and

usually along the free edges of the spleen and are usually in the ventral half of the spleen. They are red or dark being filled with blood and most are soft. They result from blood being trapped in these sites while the blood from the rest of the spleen was differentially expelled by splenic contractions. They are commonly seen in animals, mostly dogs, when euthanized. They are also seen as true lesions in dogs anesthetized before death for whatever reason which can cause a similar reaction which would then clot *in situ*, but they would be firm if found some-time later when the animal died. Most of these splenic pseudoinfarcts seen at necropsy are only a few millimeters up to a centimeter in diameter, but they may involve almost half the spleen in some cases. Probably these make up almost 50% of irregular masses found in the dog's spleen. Most other splenic masses would have a more or less rounded outline compared to these and not be found on the edges so commonly. Real infarcts can be confusing, but a source for the real ones should be found as they don't arise *de novo* very often.

C. Liver and Gall Bladder

D.

1. **Tension Lipidosis:** These are usually yellow or pale foci in the liver near the edges or any part of the liver in which there is connective tissue attachment. They have straight edges and extend as deep into the parenchyma as they are wide. They are common in horses and less so in the cow and rarely seen in other species as the dog and woodchuck. They have been called pseudoinfarcts and are thought to occur when the liver gets enlarged or for some other reason there is tension on the capsule and stroma including associated vessels causing vascular compromise and anoxia to the parenchyma with subsequent fatty change.
2. **Capsular Fibrosis:** This occurs in two forms in the horse; a large plaque of connective tissue up to 20 cm or more

on the diaphragmatic surface of the liver or as a few to large numbers of 1mm by 5 mm long, fine connective tissue tags attached also to the parietal surface of the liver. In neither case do these go deeper than the capsule as they are attached only to the capsule. The large plaque-like capsular fibrosis often has a corresponding similar lesion on the adjacent diaphragmatic serosa. Often both the multiple single tags and plaques may be found in one horse. They are also seen in newborn foals. Some say they are related to parasite migration but this is not proven.

Similar lesions can occasionally be seen in the cow. Another suspected cause is thought to be chronic peritonitis with capillary action adhesion and subsequent resolution with fibrosis.

3. **Gall Bladder Anomalies:** Anomalies such as bi- or tri-lobed gall bladders, buried bladders, extremely tortuous or other such findings are considered to be within the limits of normal variation for cats.

D. Endocrine

1. **Pseudocystic Adrenal Glands:** Most species often seem to have a central cystic cavity, even containing blood, at necropsy but almost without exception it is an artifact caused by rough pulling on the surrounding soft tissues during the necropsy.
2. **Adrenal Hemorrhage and Congestion:** This is a common finding mostly in large animals as the horse and cow and likewise in the young of those species. It is considered an artefact most of the time due to terminal increased peripheral resistance to blood flow with dying so that central pressure increases causing such hemorrhage agonally in this organ. It can also be a significant lesion in septicemia but other signs and lesions would also be found.

3. **Extra Cortical Adrenal Nodules:** In the horse mainly but also in the dog and other species, one to many pale yellow to tan, round, 1-5 mm nodules may be found bulging through the adrenal capsule. On section, they are similar to the adrenal cortex itself. They are often found in foals. There is no known cause but may represent developmental variation and no clinical disease is related to them.
4. **Thyroid Cysts:** Single, opaque, grey-white or yellow thick debris pockets may be found in one or both thyroids of sheep and goats. They are usually under 1/2 cm in diameter. Histologically, these are thyroglossal duct remnants lined by respiratory or stratified squamous epithelium with keratin debris. They cause no clinical problems.

E. Kidney and Bladder

1. **Pale Kidneys in the Cat:** As compared to the kidneys of other species, cat kidneys may be pale tan or even light cream colored. In addition to this, the cortical vessels are extremely prominent and actually groove the sub-capsular surface. These two conditions are normal. On the other hand, the kidneys may be tan to red-brown as they are in most species and likewise be normal.
2. **Renal Pelvic Mucus in the Horse:** The horse has mucous glands in the renal pelvis which may secrete enough mucus to be considered pathological by those unaware of this normal condition. A considerable amount may be found in the urinary bladder and is often considered erroneously to be frank pus. A similar finding is common in the rabbit while firmer plugs are seen in the rat.
3. **Pulpy Kidneys:** In this autolytic change seen mostly in sheep, the cortical portion of both kidneys is soft and mushy while the medullary tissue is much less affected and may be normal grossly. The same lesion can be seen

in the horse and sometimes in the cow given glucose therapy. It is probably due to high glucose and glycogen levels in the cortical tubules supplying the substrate for enhanced autolytic change as it is a well accepted procedure to test the urine for sugar in sheep with enterotoxemia which is often positive. The late Dr. P. Olafson questioned the use of an autolytic change as a diagnostic endeavor but said that it's a fact that sheep seem to have the lesion of pulpy kidneys at the time of death if not before.

4. **Renal Capsule Adhesions:** In spite of the many described instances in the literature and in textbooks, this is one of the most common fallacies in pathology. Rarely is the renal capsule truly adherent. In most cases, failure to remove the capsule cleanly is the fault of the prosector. Dehydration will cause capsule stickiness to pull off superficial cortex if one is not careful. Normal vessels, which extend from the cortex to the capsule, can cause some difficulty in capsule removal, especially in the horse and neophytes may consider these normal vessels as parasites.
5. **Umbilical Arteries:** These are two thick vessels that extend from the abdominal aorta along side the urinary bladder to the umbilicus. Normally, in newborns, these vessels have varying degrees of hemorrhage of their walls and adventitia following rupture at birth. These vessels constrict at birth and the trapped blood then clots. In the adult, they become the round ligaments of the bladder.
6. **Thickened Urinary Bladder Wall:** The thickness of the bladder wall is difficult to interpret due to normal physiologic variation. In normal animals with an empty contracted bladder, the wall is frequently startlingly thick. This should not be considered pathological (cystitis, etc.), unless fibrin, ulcers, or necrotic debris is also

present. They may be physiologically hypertropied in cases of prolonged incontinence.

F. Respiratory

1. **Nasal Ingesta:** Most of the time the finding of ingesta in the nasal cavity or as a bolus around the larynx is probably a terminal or even postmortem change. It is most difficult to evaluate unless close observation at death was made to make it significant. A ruminant can partially eructate a bolus of feed at death with subsequent propulsion of it up to the pharynx and nasal cavities by rumen gas after death.
2. **Pharyngeal Lymphoid Hyperplasia:** A very common finding in young adult horses and recognized as a marked 2-3 mm pebbly appearance of the pharyngeal mucosa of the caudal dorsal tongue and the pharynx all around the epiglottis. In most instances, it is not clinically important although some clinical cases are thought to do better with this marked lymphoid hyperplasia removed. Its cause is not known but the gastric bot, *Gasterophilus* spp., is said to be involved as part of their migration cycle.
3. **Tracheal and Pulmonary Ingesta:** This almost always is a postmortem change especially in simple stomach animals and may be due to some abdominal gas pushing content up the esophagus. Some cases may be due to postmortem handling of the carcass. It is necessary to see a tissue reaction to make it an antimortem lesion although who is to say it didn't occur antimortem but in too short a period to get a tissue response.
4. **Tracheal Froth:** Certainly this may be a lesion in some cases but as we can kill a horse or other animal by electrocution and find this marked tracheal froth production even with froth flowing from the nostrils, then its

significance in other cases can be suspect if there is no reason for its being found. In intentionally electrocuted animals, the electric shock is given for several minutes during which time the body is in extensor rigidity with stopped cardiorespiratory movement but the elastic recoil of the vessels continues and pushes serum from the pulmonary capillary bed into the alveoli. Apparently on cessation of the electric shock, the carcass relaxes and the inflated lungs deflate pushing pulmonary air and serum out mixing it to a froth as it does. This results in the tracheobronchial froth, which with time, can extend out the nostrils. We can reproduce this in many euthanasia animals and is not to be confused with the clinically significant interstitial pulmonary edema.

5. **Pleural Fibrosis:** These are large incomplete areas of pale connective tissue on the surface of the dorsal diaphragmatic lobes of the lungs in most species but are most prominent in the cow and sheep. It is especially pronounced in the uninflated lungs of aborted fetuses. It is a normal anatomical feature in these animals.
6. **Pulmonary Emphysema:** One of the most commonly misunderstood findings in animals is that of pulmonary emphysema. It is rarely of any significance in any species unless the clinical signs were seen to corroborate dyspnea. It is a very common finding in cows that die for almost any reason, so its significance in them has to be very critically evaluated. Cats to a slightly lesser degree develop this change very commonly with a horse slightly less than the cat. Probably it is best in all species to ignore it without a history of dyspnea. One would make less errors following this advice. It is recognized as more air in the lung than normal and may form large bullae up to 10-15 cm in diameter in cattle.
7. **Pulmonary Congestion and Edema:** This is recognized as a more or less mottled reddened lung which is heavier

than normal. It is not firm so it is not pneumonia. On cut section, it is very bloody and much blood can escape into the airways. Without a specific cause, this is almost always an artifact of blood pooling in the lungs at and after death as it's pushed out of muscles by rigor mortis and out of the abdominal cavity by gastrointestinal gas production. This is another nonlesion that is always best to ignore and possibly make a few mistakes in gross diagnosis than constantly misdiagnose it as a significant lesion.

G. Cardiovascular

1. **Lack of Apparent Rigor Mortis:** A common finding in many animals is the finding of an extremely flaccid heart for a quite variable period after death. In most instances, no significance can be attributed to this finding. It may be and usually is seen in both left and right hearts and is often seen when the heart is examined soon after death and before rigor mortis has set in. In large animals as the horse and cow, it is surprising how long it takes for rigor to set in but in time, it usually will, though its absence is difficult to interpret. In such cases as anthrax, it is probable that the failure to see rigor in the heart is really because the rigor has already occurred but too rapidly and too incompletely to be recognized.
2. **Pericardial, Endocardial and Myocardial Hemorrhage:** These petechiae and ecchymotic hemorrhages, when seen in large animals especially, usually have no significance and are considered to be terminal findings as the result of increased peripheral resistance in the limbs with intermittent forceful cardiac contractions, associated with dying for almost any reason. The heart then pumps against this increased peripheral resistance and causes these hemorrhages throughout the various parts of the heart, mediastinum and costal pleura. Some may be seen on the diaphragm, in the adrenals and scattered

other tissues. These are usually only petechiae or ecchymoses but if they are more serious, such as suffusions or even closer to hematomas in these areas, then they may be more significant and represent a bleeding or clotting problem. They can sometimes be seen in small animals with the same significance. They are often seen in septicemias and toxemias, but as they can so often be seen in nonseptic and nontoxic conditions, their significance should be questioned and other diagnostic features of septicemias or toxemias looked for.

3. **Edema of the Heart Valves:** All four major valves, including all their cusps, may be markedly thickened even up to 5 mm with a clear, watery fluid giving the valve a swollen, shiny appearance. While most of the cusps may be involved in any one case, it is often found that only one or two cusps out of three may be involved with one of the cusps or even part of a cusps being completely normal. In addition, it is also often noted that the base of the cusps may be similarly swollen with clear, edematous fluid. This is a common finding and of no diagnostic value, but one has to differentiate it from the firm, irregular, warty nodules on the free edges of the A-V valves commonly seen in older dogs called verrucous endocardiosis. One suspected cause of the valvular edema is thought to be the slowing of blood flow at death in cases of prolonged periods of dying, either naturally or from euthanasia.
4. **Endocardial Fat:** In obese animals or even in normally conditioned animals of most species, there may be small pale foci of fat 1-2 mm or even up to several centimeters in and under the endocardium of both ventricles. It does not extend deeper than the endocardium unless it follows natural clefts in the endocardium itself, and often it is seen slightly more extensively around the attachment areas of the moderator bands. This deposition of normal fat is usually more extensive in excessively fat cattle or horses.

5. **Nodules of Arantius:** These small, 1-2 mm firm pale foci in the middle of the free edge of the cusps of the aortic valve are normal structures, most notable in pigs, but may be seen or felt in other animals. They are to be differentiated from strongyle granulomas on the aortic cusps or horses which are irregular in location and size. They must also be differentiated from the common friction rubs seen on the aortic cusps of horses also but which are opposition lesions and thus paired where the cusps rub together nearer the cusp attachment sites and are found in mature and older horses only.
6. **Ossa cordis:** These are two normal bones found at the base of the heart in the cow. They are relatively thin, curved, triangular-shaped bones often confused for abnormal ossification of the fibrous ring. Small, irregular pieces of bone can also be felt in the fibrous ring at the base of the heart in most species as they age. These are also normal.

H. Bone

1. **Synovial Fossa:** These are normal shallow to relatively deep irregular depressions in the articular surfaces of some joints in horses particularly. These are developmental structures that may not be seen at birth but develop later. They are thought to help in the distribution of synovia.

I. Central Nervous System

1. **Pia-arachnoid Lipidosis:** This is the normal opaque white deposit present in the meninges of old animals, especially dogs. It is concentrated deep in the sulci, primarily over the cerebral cortex and the ventral surface of the brain. The cause is considered to be the normal wear and tear of the CNS parenchyma with lipid release and its ultimate precipitation along with foamy phagocytes in these areas.

J. Fetus

1. **Umbilical Cord Twisting:** There may be one or up to seven twists in the umbilical cord of the normal placenta in foals without causing any problem. If there is excessive edema, tissue tearing of the cord, fibrosis or emaciation of the foal or other evidence of vascular embarrassment in the cord including urachal and bladder distension in the foal, then the twists may be of importance but if lesions aren't found, then the few twists should be considered normal.
2. **Placental Deposits:** Scattered opaque white mineral deposits of calcium of 1-5 mm. diameter are seen often on the chorion of cows, sheep and pigs. These are considered physiological and occur only during a part of pregnancy. Another common finding are the rounded yellowish-green to white plaques often in linear arrangement on the amnion of horses, sheep and cattle. Many are rounded and have a depressed circular-ringed center. These are again common findings but without a cause or effect. They peel off easily. Brown-tan flat rubbery masses, hippomanes, from 2-10 or more cm in diameter are also found quite freely in the allantoic fluid of horses and cows. Usually only one or two are found and when cut in half, many, not all, have a central laminated appearance suggesting that they may have once been spherical but are now collapsed. Their source is still in question.

K. Gastrointestinal

1. **Glossal Fimbriae:** These are fleshy, usually flat, papilliferous 5-10 mm epithelial projections from the edge of the tongue in newborn normal piglets. Their cause and use is not known, but they usually disappear shortly after birth.

2. **Idiopathic Hypertrophy of the Distal Esophagus:** This is recognized as the pale thickened muscle in the entire distal half or less, usually distal 1/10, of the esophagus just as it enters the stomach. In a very few cases, almost the entire esophagus can be involved and in a few cases, the muscle hypertrophy can extend into the muscle of the stomach proper. Clinical problems are seen in only 1-2% of horses so that some consider it almost normal.
3. **Ungiculate Papillae:** These may be tiny 1-2 mm or up to several centimeters firm cornified papillae found at the distal end of the esophageal groove and omasum in ruminants. These are normal structures and in the young milk fed animals, they are often opaque white while in older animals, they get dark with ingested pigments. It helps to remember that unguiculate refers to claw-like and ungulate refers to hoof.
4. **Rumen Mucosal Sloughing:** Sometimes as early as twenty minutes after death, the lining of the rumen may peel off in large patches leaving a pale or intensely reddened submucosa, depending upon whether or not the animal was bled out at the time of sacrifice. It is often mistakenly called a hemorrhagic inflammation but no exudate, edema, or hemorrhage is present to corroborate this impression.
5. **Torus Pyloric:** This is a discrete swelling in the gastric wall at the junction of the pyloric portion of the stomach and the duodenum. In the pig, it is quite large with a central groove. It is just a smooth hump in the cow and even less prominent in most other species. It is also one of the most commonly misdiagnosed normal anatomic features in animals.
6. **Gastrointestinal Mucus:** This appears as the thick usually yellowish brown or pale white mucoid material loosely adherent to the stomach and small intestine mucosa.

It can be easily scraped off with no underlying ulceration or inflammation and if the surface is kept moist, more of the same mucoid material may form in the same area by apparent extrusion from the underlying mucous glands. This normal material has often erroneously been called a catarrhal exudate. This normal finding of mucus is seen in most species but is especially prominent in the stomach of horses and pigs.

7. **Gastric Hyperemia:** The more or less intensive reddening of the glandular mucosa of the stomach is a common physiological finding in many animal stomachs especially in the horse and pig. The lack of free hemorrhage, exudate, ulcers or edema is further evidence that it's not gastritis which it is often mistaken for. It can be extremely extensive and remarkably red in pigs and still be within normal limits.
8. **Post Mortem Gastric Ruptures:** These are usually identified as being large erosive areas of thin gastric wall through which one or many openings are present allowing content escape. The edges are thin and discrete; thickened walled ulcers are not apparent. Post-mortem digestion by the acid gastric juice is the usual cause in most species. They are quite common in the dog, calves and rabbits. Some consider that the ones found in rabbits are associated with hair balls.
9. **Duodenal Papillae:** These are two mucosal nodules, one larger than the other, seen in the beginning of the duodenum of most species. They are normal structures representing the openings of the bile and pancreatic ducts. In many instances, they are erroneously considered to be polyps or neoplasia, especially in the horse in which the major papilla is very prominent.
10. **Post Mortem Bile Dilatation of the Bowel:** Often one sees discrete foci of small intestine, often the duodenum,

dilated and thin walled to two or three bowel diameters which have a distinctly green color through the serosa. Bile is extremely caustic and when some is released into the duodenum at death, it may be propelled in small bolus amounts by continued postmortem peristalsis to cause this relatively common postmortem artefact in many species but especially in dogs.

11. **Segmental Intestinal Hyperemia with and without Diapedesis:** Commonly in all species segmental areas of congestion of the small intestinal tract are found and these are just areas of physiological hyperemia interspersed with noncongested segments. With time after death the mucosal vessels may break down with resulting hemorrhage-like blood in the lumen. They should not be considered as evidence of hemorrhagic enteritis without evidence of edema, necrosis or ulceration. Sometimes large segments and at other times only small segments may be involved but all should be considered postmortem artefacts.
12. **Post Mortem Intussusception:** This occurs when a section of intestine (the intussusceptum) has invaginated into a portion of bowel (the intussusciens) cranial or caudal to it. There is no vascular response such as edema, hemorrhage, or fibrin accumulation seen with this, although the intussusception may be slightly more congested than the rest of the bowel. This is considered to be a terminal or post mortem event in all species as peristalsis continues even after death.
13. **Intestinal Lymphoid Follicles:** These are most commonly seen as opaque, pale, round, several millimeter in diameter foci often with a tiny dark center scattered throughout the cecum and colon. These are most prominent in the dog and pig. Other aggregates of lymphoid tissue—oval or linear plaques or even areas encompassing the entire circumference may be the Peyer's patches

seen in the distal ileum, jejunum and sometimes surprisingly in the duodenum.

14. **Tiger Striping:** Linear patches of reddening of the colonic mucosa, often in the rectum proper and sometimes also in the urinary bladder. Blood is trapped in these superficial areas of the mucosal folds as the animal terminally strains to urinate or defecate. Rarely is it of diagnostic significance.

The Smells of Pathology

One of the most important senses we possess is often neglected at the necropsy table: the use of the sense of smell. Thus odors, or a few of them, will be discussed here. The actual description of an odor is difficult or often impossible and so may best be identified by comparison. For example, try to tell someone how an orange smells. . .

Blackleg: This disease, caused by *Clostridium chauvoei* has the distinct odor of the goat acids or rancid butter. This odor has also been noticed in some cases of *Cl. septicum* infection in pigs and horses.

Salmonellosis: In all species, the affected, non-treated intestine has a distinct septic tank odor. This does not mean the fecal odor itself, or even the odor of decay. A septic tank odor is the best description.

Ascariasis: In most species, these large round worms give off a sickening sweet odor. This is especially true when many sexually mature worms are present.

Septic mastitis: While often overlooked initially, the dark firm mammary gland found at necropsy has a definite odor of fermentation. The odor becomes more prominent as the gland lies open exposed to the air and the color also darkens.

Urea poisoning: In some cases, a sharp ammonia odor may be noted when the rumen is opened.

Myiasis: In sheep's wool, dog's hair, or anywhere, maggots have a sickening odor of their own.

Mange: Mange mites of several genera give off a definite odor peculiar to that species. Dogs and foxes are especially noted when affected with sarcoptic mange.

Onion poisoning: This obvious odor is no problem except that glycerol gualacolate with propylene glycol, a commonly used presurgical drug, will give off a similar odor. Propylene glycol in the rumen content also gives off this odor.

Motor oil: Everyone knows this odor. Its importance in pathology is related to the toxic factor, lead, that is contained in it.

Nembutal: As with other medicinals, nembutal has a background alcoholic odor; but, in addition, a sweet odor is present. This is most easily noticed in the lungs of the animals killed with this drug.

***Corynebacterium pyogenes*:** A very characteristic odor is often associated with large accumulations of fluid pus as in traumatic pericarditis or peritonitis.

***Fusobacterium necrophorum*:** The odor of foot rot is one of the best examples.

Turpentine, Cresol, Turcapsol: These pine related odors are most distinct and are most often related to treatment.

Apple cider: Many times, but not all, blood in large quantity in the stomach of pigs especially or cattle caused by bleeding ulcers often give the opened carcass and indeed the entire necropsy area the smell of fresh apple cider.

Salmon poisoning disease in dogs and probably foxes or other affected canids gives off its own distinctive odor.

Garlic: Often in cases of poisoning with organic phosphates, the rumen content and the insecticide material itself gives off a garlic-like odor, and we have noted it in a few animals with plant related Vitamin E/Selenium white muscle disease.

Surprisingly there are several odors, such as uremia, and ketosis, which have been described by others but have not been identified with certainty by us. We would appreciate knowing of other "helpful" odors.

Brief Comments on Neoplasia

1. A lump is just a lump until proven otherwise by histological study or other means. A good reason for invention of the microscope.
2. Certain tumors can be presumptively diagnosed grossly, because of the animal's history or the prosecutor's experience, but a mass by itself could be one of several conditions including inflammatory granulomas.
3. Lymphosarcoma can mimic almost any condition, clinically, and can occur in any age animal, even aborted fetuses.
4. In some species, such as the dog and cat, there are certainly specific tumor ages (about seven years in these animals) and conversely masses seen in them may not be neoplastic. This is variable among different species.
5. Without evidence of prior damage in an organ, such as the liver or thyroid, multiple lumps probably represent neoplasia and not compensatory hyperplasia or regeneration. Thus, the commonly seen mass or masses of liver-appearing tissue in older dog's livers are probably the benign hepatomas.

The Time of Death

Death, as we know, is the culmination of dying, but to establish the exact time is often difficult. A few generalities can be used.

Rigor mortis, the stiffening of death, is best related to the body temperature and the metabolic activity at the time of death. If death occurs during any high fever disease such as Porcine Stress Syndrome of pigs, heat stroke, or anthrax in most species, rigor can occur almost simultaneously with death. Also, it occurs rapidly in animals that are excited or severely stressed just before

death. The opposite is true for animals that are moribund or cachectic for some period before death. In these latter cases, rigor may not occur for hours. The length of time a body is in rigor is directly related to the onset as is the post rigor relaxation time. An animal that takes minutes to go into rigor will only have a short period of rigor.

The jaw muscles of dogs and most animals are the first to set up in rigor followed by the eyelids, tail, toes, distal limb muscles and finally the larger limb muscles. They relax in a similar sequence.

Remember that once rigor has been broken by moving the body or limb, the rigor will not return. In human forensic medicine, this may have a bearing if only the arm with the gun has no rigor and all other muscles are stiff.

Algor mortis, the cooling of the carcass with death, is another useful but not absolute parameter to be noted. Rectal, oral, axillary or even deep muscle, abdominal or heart blood temperature are at best only suggestive as they vary so widely after death. Ambient temperature is important in its interpretation. In one second year class experiment here, the best location to take the carcass temperature was through a hole punched in the skull. An extra long thermometer was pushed through the brain to the floor of the skull. The temperature here decreased in a relatively straight line to ambient temperature about 18 hours after death. In all other locations, 12 different ones, the temperature varied too much for evaluation of time of death. In an obese or heavily-haired or wool-covered carcass, the values have to be suspect. When a heavily-wooled sheep is put in the necropsy refrigerator or left out in freezing weather, its body temperature will increase for hours because of insulation afforded by the wool and the heat produced by continued fermentation in the gastrointestinal tract.

Corneal clouding, at least in dogs, begins not sooner than 25 hours after death. Closed eyelids help this evaluation by preventing corneal dehydration and temperature does not seem to affect this parameter.

Clouding of the lens of most species is quite variable and the most apropos comment to make here is that the lens clouds easily when cold. Such cloudiness is often mistaken for cataracts. To differentiate from true cataracts, one has only to warm the head and eyes, and these "cold cataracts" will disappear.

Rumen mucosal sloughing is a difficult evaluation as it can begin within twenty minutes in the "normal cow." This usually takes several hours however.

Blood glucose drops rapidly about 20 minutes or so after death while some other biochemical values, such as calcium or other blood minerals, may not decrease over much longer periods. Comparison with C.S.F. values may be helpful for some. On the other hand, the continued plateau of glucose levels may indicate a poisoning by sodium fluoroacetate which prevents glucose's enzymatic breakdown. Blood urea nitrogen (B.U.N.) does not increase after death as many believe, but instead plateaus for up to 3-4 hours before gradually decreasing.

Food digestion, in particular the stage of digestion, may sometimes be helpful in ruling out a specific time of death, but is not considered a good estimator for time of death.

Other related aspects can be useful to determine time of death. For instance, the consistent developmental stages of identifiable eggs or maggots on a flyblown carcass may indicate when the wound or carcass became flyblown and may thus be an indication of time of death.

Although not related to time of death, I'd like to suggest that one rather unique way to slow down decomposition is to bury the carcass in the cool earth. This will often delay autolysis considerably if no other means of preservation is available. A freshly dead cat buried for a week like this is difficult to tell from one just cooled out for a couple of hours.